DRAFT

# ESTABLISHING compatibility

**Richard Norsworthy, Lone Star Corrosion Services, Polyguard Products Inc., USA,** argues the importance of understanding how pipeline coatings work in conjunction with cathodic protection.

When selecting a pipeline coating, the 'fail safe' characteristics may be more important than other issues that are normally considered.[1] Cathodic disbondment tests are an important standard for pipeline coatings, but not the only one to be considered when discussing cathodic protection (CP). To adequately protect underground pipelines, a coating must conduct CP current when disbondment occurs.[2] Certain coating types shield (block) CP current when disbondment occurs and water can penetrate between the coating and the pipe, allowing corrosion to develop. Some pipeline coatings are compatible with CP in a way that allows current to protect the pipe if disbondment occurs. These are considered to be 'fail safe' coatings.

## An ageing problem

As pipelines age, coatings typically deteriorate and disbond. Companies become aware of the high cost of maintaining these lines, especially when corrosion problems require shutting down or reducing throughput. Thousands of miles of coated pipelines are operating beyond the design life of their coating system. Every coating system has finite life and eventually degrades, allowing oxygen, water and chemicals to reach the substrate.[3] In many cases, the only solution considered is to increase the amount of cathodic protection. Increasing cathodic protection (CP) may help to meet certain criteria and protect exposed pipe, but it does not protect under many types of disbonded coatings, therefore corrosion will continue unless these coatings are replaced. Increasing CP can create other problems, including further disbondment and coating deterioration.

Pipeline coatings fail and disbond for various reasons other than CP, including poor surface preparation, application or selection of the wrong coating for the environment. Each time a pipeline coating is selected, one needs to consider what will happen if the coating system adhesion fails. Will the coating shield CP if the bond fails?[4] Even though all coatings are formulated to not fail when properly selected and applied, there are many reasons why failures occur. Water permeation, loss of adhesion, loss of cohesion, blistering and cathodic disbondment are ways a pipeline coating can fail. Generally, any changes in the properties of a coating are considered as a coating failure.[5] One may realise, however, that as the coating deteriorates and as its permeability to $O_2$ increases, the corrosion rate deep in the crevice (or in the blister) could become substantial as CP is shielded there.[6]

Soil stress and other mechanical damage can also create serious disbondment problems with pipeline coatings. This is especially true for shrink sleeves and solid film backed tape coatings. Damage to the coating can occur from expansion and contraction of the pipeline. Damage in the circumferential direction happens from soil weight and settling, and damage in random directions can happen due to soil swelling and shrinking, as with wet and dry cycles. This may lead to pipeline corrosion failure and costly repair.[7]

## New and replacement coatings

Some pipeline coatings have been known to fail by disbondment only a few years after application. In some cases, soil stress may cause disbondment to occur early on after the coated pipe is backfilled. Companies have installed FBE ('fail safe') coated pipelines with a different (not 'fail safe') girth-weld coating. Whether these girth weld coatings fail from soil stress, poor application or other ways, internal line inspection tools have shown significant corrosion on some of these girth welds after only a few years in service. This has been especially true for some shrink sleeves and solid film backed tape products. Two part epoxies have had problems with adhesion and cracking, especially when applied as a girth weld coating on three layer coating systems.

Rehabilitation coatings have the same issues and should be carefully selected for their 'fail safe' characteristics. Companies have performed expensive rehabilitations only to find their choice of coating material disbonded and was not 'fail safe', requiring further expense. 'Fail safe' coatings at least give us the opportunity to increase CP current (if needed) to protect the pipe should the coating disbond, thereby saving the cost of recoating.

**Figure 1. pH of 5 under disbonded coal tar coating with significant corrosion present (not 'fail safe').**

**Figure 2. Even though blisters and poor adhesion were a problem, the steel under the FBE coating shows to be in excellent condition, proving 'fail safe' properties.**

## Still searching for the perfect coating

The industry has struggled to find a perfect pipeline coating. Even though some have proclaimed to have such, none has been proven to be so. Each coating type has unique problems that are inherent in that coating type. Some in the industry recognise the importance of choosing pipeline coatings that allow cathodic protection to work even if the coating disbonds and water enters the disbonded area. However, all coatings experience disbondment and, therefore, the behaviour of a disbonded coating is important in the overall performance of a coating system.[8]

Dielectric strength is an often misunderstood coating property. All coatings have varying dielectric properties that reduce the tendency of the electrolyte to complete the electrical circuit between the adjacent anodic and cathodic sites on a substrate, thereby mitigating corrosion.[9] Each coating to be used with cathodic protection must have a certain amount of dielectric strength. Given the fact that coatings have different dielectric strength, it does not follow that a coating with high dielectric strength is superior to one with a lower dielectric strength. Beyond a certain point, dielectric strength has very little use when considering current attenuation. Typically, the highest dielectric strength coatings are those that create the most dramatic shielding problems if there is a loss of adhesion (disbondment) and oxygen and water penetrates. The worst case scenario of coating failure is the one in which the coating no longer protects the pipeline, and, in addition, the coating prevents the CP from protecting the pipeline.[10] As a result of this failure to understand the influence of the coating, especially on the CP system, many premature pipeline failures have occurred.[11]

**Figure 3. Severe soil stress caused coal tar coating to disbond and CP shielding caused corrosion (not 'fail safe').**

## 'Fail safe' coatings

Not all coating failures result in corrosion on the pipeline. Some coating failures have little or no effect on the corrosion rate of the pipe. If the coating is a 'fail safe' coating, CP can actually provide some protective current to pipe if water is present between the coating and the pipe. It is the author's belief that there are two coatings that have been proven to have 'fail safe' characteristics and these are Fusion Bonded Epoxy and Polyguard's RD-6 pipeline coating system.

No claim is made that these two coating systems are 100% 'fail safe' in all conditions, but field and laboratory results have proven this characteristic does exist.[12] FBE has been used for approximately 40 years. In that time there have been numerous FBE failures reported, analysed and researched, yet it has been very rare to find corrosion or Stress Corrosion Cracking (SCC). However, the electrical resistance is low enough to allow cathodic protection to prevent corrosion on the pipe with disbonded or blistering coating - FBE is non-shielding.[13] Usually there is a high pH of any water under the FBE, indicating CP current is actually penetrating the FBE to provide adequate protection to the pipe.

Polyguard's RD-6 has been used for 19 years on many coating rehabilitation jobs and as a girth weld coating on various main line coating systems. Though rare, there have been some disbondments, but no detrimental corrosion. These disbondments have been associated with poor application techniques, such as improper tension. When tested, the pH of water under these disbondments was in the range of 10 to 11. When adequate CP is present, corrosion, including SCC, is significantly reduced or eliminated if water penetrates under the coating.[14]

There are many reasons to use a pipeline coating in a roll form. The surface preparation requirements are much less than for two part epoxies and shrink sleeves. No complicated equipment is required, no torches (unless for bringing the steel temperature above dew point), no cure time, immediate back fill and the RD-6 is compatible with most other coating systems when performing rehabilitation or girth weld coating.

## Conclusion

There are several reasons to use a 'fail safe' pipeline coating. When CP-compatible coatings degrade or ground water contacts the pipe, the surface is still protected from corrosion and SCC because the CP current can pass through the

permeable coating.[15] Being CP compatible is significantly more important that passing a CD test in a lab. There are many ways that a coating can disbond, so a coating is needed that will allow the CP to work if disbondment occurs.

There is significant proof that the use of 'fail safe' coatings allows the end user to have confidence in the fact that when any portion their choice of a coating system fails, CP can protect the pipe, thereby reducing the threat of significant corrosion or SCC.

NACE International now offers a course titled 'Coating Used in Conjunction with Cathodic Protection'. This course provides the students with an opportunity to understand how coatings and CP work together and the problems that can exist when using these two protection methods at the same time.

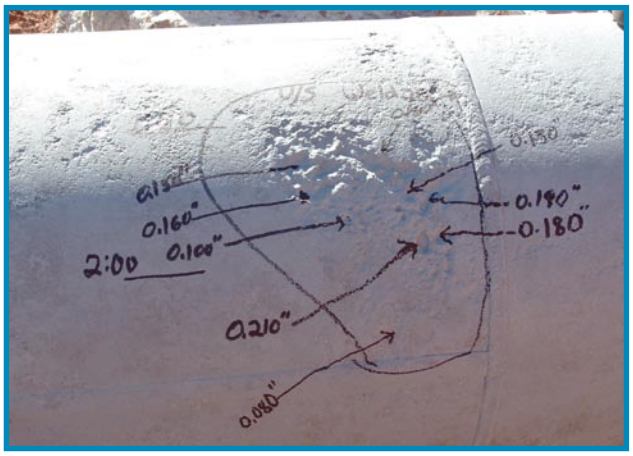


**Figure 4. Corrosion found under tape coating that was not 'Fail Safe'.**

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