

IS YOUR PIPELINE COATING “FAIL SAFE”?

When selecting a pipeline coating, the “Fail Safe” characteristics may be more important than other issues that are normally considered.

Pipeline integrity in an aging pipeline infrastructure has given the opportunity to learn about how the selection of coatings is critical in controlling external corrosion on cathodically protected pipelines. A major cause of external corrosion on pipelines is disbonded (loss of adhesion) pipeline coatings that shield cathodic protection (CP) current. The disbonded coating allows water to penetrate between the coating and the pipe allowing corrosion cells to develop. If the pipeline coating is not “Fail Safe”, CP can not protect the pipe. A “Fail Safe” coating system is defined as one that will allow cathodic protection current to pass through it to protect the substrate – not shield CP – should the coating bond fail and adequate CP is available.ⁱ Therefore, “Fail Safe” coatings will significantly reduce or eliminate corrosion, including stress corrosion cracking, on the pipe under the coating if the bond failure occurs, water penetrates and cathodic protection is adequate.

Polyguard Products, Inc. has a pipeline coating system that provides “Fail Safe” properties incorporated with significantly reduced soil stress problems and shielding problems. This coating system (Polyguard RD-6) has been successfully used for over 15 years, but the “Fail Safe” technology is just now being understood by many in the pipeline industry. Fusion Bonded Epoxy (FBE) coatings are known to be “Fail Safe”.

WHY FAIL SAFE COATINGS?

Several papers refer to this characteristic which may be called “Fail Safe”, “CP Compatible”, or “CP Friendly”. When these coatings (CP-compatible) degrade or groundwater contacts the pipe, the surface is still protected from corrosion and stress corrosion cracking (SCC) as the CP current can pass through the permeable coating.ⁱⁱ It is believed that the high permeability of FBE coating to water is the reason for the apparently “transparent” nature of FBE coating to the cathodic protection.ⁱⁱⁱ (*insert photos of FBE*) Stress corrosion cracking has been studied extensively and has never been observed on FBE coated pipelines in over thirty years.^{iv} Upon inspection of another FBE coated pipe these comments were made “There was no measurable wall loss beneath either of the blisters and the pH of the moisture under the blisters was greater than 10.”^v

WHAT HAPPENS IF THE COATING IS NOT FAIL SAFE?

Soil stress, poor surface preparation, poor application techniques, selection of the wrong coating for the service, and variety of other reasons are why pipeline coatings disbond

during service. (*Insert photos of wrinkled tape*) When a coating system fails, the question one must ask is “Will the coating shield CP if the bond fails?”^{vi}

The use of coatings that shield CP has also been well documented. Shrink sleeves and polyethylene tape wrap coatings for girth welds are known to cause problems with cathodic protection shielding.ⁱⁱⁱ (*Insert photos of shrink sleeves*) Even with adequate cathodic protection corrosion can occur under most disbonded coatings.^{vii} But where tape merely lifts and cracks, moisture gets underneath and, because tape (Solid film backed and not “Fail Safe”) acts as an insulator, begins corroding the pipe.^{viii} The repairs were necessitated because of failures of Butyl rubber/PVC or polyethylene-laminate wrapping tapes and spray applied reinforced polyester.^{ix}

These are only a few of the articles that mention cathodic protection shielding caused by coatings such as shrink sleeves, solid film backed tape, extruded polyolefin, coal tar and asphalt enamel coatings and others that do not allow current to pass should the coating bond fail. Two part epoxies and other liquid coatings for girth welds and rehabilitation have become very popular, but are these coatings “Fail Safe”. One paperⁱⁱⁱ discusses testing of liquid coatings and concludes that the thickness and cracks at blisters are critical as to whether they are “CP Friendly”. The formulations of two part epoxies are different than that of FBE coatings and therefore may not offer the same “Fail Safe” properties as FBE.

Typically, if the bond is good there is no water buildup between the coating and the pipe, therefore neither corrosion nor SCC is usually a problem. Even when water permeable coatings absorb water or allows water to penetrate by other methods, the water does not present a problem as long as the coating is well bonded to the pipe surface. The type of coating chosen can lead to potential pipeline corrosion and failure if water penetrates between the coating and the pipe and the coating does not have “Fail Safe” characteristics. **When selecting a pipeline coating, the “Fail Safe” characteristics may be more important than other issues that are normally considered.**

ADVANTAGES OF ONE “FAIL SAFE” COATING

The advantages of selecting a “Fail Safe” coating system are many. For the woven geotextile mesh backed wrap system (Polyguard RD-6) the advantages are:

1. When adequate CP is present, corrosion, including stress corrosion cracking is significantly reduced or eliminated if water penetrates under the coating.
2. Field and lab proven “Fail Safe” properties (similar to FBE)ⁱ There is typically a change in the pH to between 10 and 13 under the disbondment proving that the pipe is getting adequate CP.
3. This coating system provides an excellent choice for rehabilitation, girth welds and repairing pipeline coatings to provide improved pipeline integrity and safety.

4. The woven geo-textile mesh backing is very resistant to soil stress effects, especially when the complete system includes the use of un-bonded (slip plane type) outer wrap.
5. Less stringent surface preparation, ease of application, easy clean up, mixing or off ratio concerns and no cure time (no sophisticated equipment needed).
6. No heat required for application which is much safer for applicators and removes the problems with over or under heating, etc.
7. The compound is compatible with most other pipeline coatings.
8. Because current can penetrate at the areas of disbondment, these areas can be located by the use of Direct Current Voltage Gradient (DCVG) surveys.
9. Since the coating is “Fail Safe”, the end user does not have to be as concerned about replacing the coating immediately.
10. Compatible with cathodic protection (over 15 years of test data and in-service life).
11. Resistant to microbiological attack.
12. There are no known failures after over 15 years of service when proper surface preparation and application were used.
13. The two times water has been found under this coating (once was an application problem and one was intentionally applied to a wet pipe) the pH was 10 to 11 indicating adequate CP for protection is being achieved under the disbonded area.

(insert photos of RD-6)

PIPELINE INTEGRITY

With all the pipeline integrity work being performed today through internal inspection tool data and External Corrosion Direct Assessment (ECDA), the choice of coatings for repair becomes critical. Not only should we look at cost, we should also be sure that we are choosing coating systems that are improvements over those that have failed and shielded the CP. There are many choices available to the industry, but most are not “Fail Safe”. Each choice should include the question “Is your pipeline coating Fail Safe”?

A very good example of this is to review internal line inspection (ILI) tool data for FBE coated pipelines. How many times do we find external corrosion on FBE coated pipelines? Rarely and when we do the cause is usually a shielding effect from some foreign structure around the pipe, not shielding from the FBE. In one case a large boulder was setting on top of the pipe (See photo). There was a significant pit under the boulder, but no other corrosion, even though there were several blisters in the FBE in this area.

The addition of more cathodic protection is not the answer to controlling corrosion under disbonded coating unless the coating is “Fail Safe”. Many papers have been written to confirm this, but time and space do not allow for this to be addressed.

SUMMARY

By selecting “Fail Safe” pipeline coating systems, the likelihood of reoccurring corrosion under disbonded coatings is significantly reduced or eliminated with adequate CP. This wise choice of a “Fail Safe” pipeline coating for rehabilitation of the aging pipeline infrastructure now allows companies to use the money that was to be used for future repair and rehabilitation of these pipelines on investments that are more profitable endeavors.

“Fail Safe” coatings are also less susceptible to stress corrosion cracking. Most of the intergranular failures have been on pipes coated with a coal tar primer and coal tar enamel reinforced with felt or fibre glass, although some failures have occurred with asphalt or tape coated systems, but none with thin film (FBE) coatings.^x There have been other documented cases of corrosion under solid film backed tape, shrink sleeves and other very high dielectric strength coatings. The ability of coatings such as FBE or the geo- textile mesh strands of the RD-6 to permit CP current to penetrate to the pipe surface if disbondment occurs, accounts for the higher potential and subsequent change in pH of any water that may be present. Therefore, the chance of significant corrosion or SCC is less likely. Only “Fail Safe” coatings allow this process.

Since FBE is not easily applied in the field except to girth welds, it is not considered a rehabilitation coating. The alternative is to use another coating, such as the Polyguard RD-6, that has been proven to be “Fail Safe” through field observations and laboratory testing. The “Fail Safe” choices are limited. At this time, few pipeline coatings have actually been tested for these characteristics. Therefore the question to your coating vendor should be “Has your pipeline coating been proven to be Fail Safe?”.

Corrosion engineers are asked to evaluate numerous and different materials and processes for use by their companies to help mitigate their corrosion problems and it’s cost. One consideration in this process is the choice of coatings used in conjunction with CP. Repeating the advice above, when selecting a pipeline coating, the “Fail Safe” characteristics may be more important than other issues that are normally considered.

ⁱ R. Norsworthy, “Fail Safe Tape System Used in Conjunction with Cathodic Protection”, Materials Performance, June 2004, Pg. 34

ⁱⁱ F. King, T. Jack, M. Kolar, & R. Worthingham; “A Permeable Coating Model for Predicting the Environment at the Pipe Surface Under CP-Compatible Coatings”; CORROSION 2004, Paper 04158, pg. 1

ⁱⁱⁱ G. R. Ruschau, “Determining the CP Shielding Behavior of Pipeline Coatings in the Laboratory”; CORROSION 2006, Paper 06043, pg.2

^{iv} D. Neal, “Pipeline Coatings Failure – Not Always What You Think It Is”, CORROSION 2000, Paper 00755, pg. 5

^v T. Fore, K. Varughese, “First Generation of Fusion Bonded Epoxy Coatings Performance After 30 Years of Service – A Case Study”; CORROSION 2006, Paper 06045, pg. 3

^{vi} D. P. Moore, “Cathodic Shielding Can Be a Major Problem After a Coating Fails” MP 39, 4, 2000, pg. 44

^{vii} R. Norsworthy, “Select Effective Pipeline Coatings”, Hart’s Pipeline Digest, February 1997, pg. 17

^{viii} G. Koch, “A Test of Stress”, Oil Week, October 17, 1994, pg. 16

^{ix} J. Beaver, N. G. Thompson, “Corrosion Beneath Disbonded Pipeline Coatings”; Materials Performance, April 1997, pg. 13

^x R. N. Parkins, “Stress Corrosion Cracking of Pipelines – Its Control or Prevention”, CORROSION 96, Paper 249