
COUNTERACTING
CORROSION
COMPLICATIONS

Caroline A. Fisher, Bryan Karasek, Rick Kimpel and Zachary Phillips, Aegion Coating Services, USA, highlight the developments in prevention coatings for corrosion in pipeline projects.

Most pipeline owners want the best corrosion prevention possible for their pipeline for as long as possible and at the best price. After all, pipelines are the safest mode of transportation for many gas and liquid products. External corrosion, the primary cause of pipeline failure due to reduction in wall thickness, leads to leaks, rupture and stress cracking. In fact, half of the onshore pipeline incidents between 1998 and 2008 occurred with liquid pipelines. A significant percentage also included gas transmission pipelines.[1]

It is well known that external corrosion's 'first line of defense' is coatings plus cathodic protection. Likewise, to address internal corrosion concerns, NACE International recommends that pipelines be internally coated "as an internal corrosion control measure."[2] Internal coatings that extend to the internal field joints enhance product purity and flow. The solution to these corrosion problems is overwhelmingly prevention coatings. However, the formula for best practice is not just applying a coating. It is the sum of the surface preparation with coating, application and inspection that transforms coating into a reliable corrosion prevention plan.

Aegion Coating Services (ACS) group – consisting of CRTS and CCSI – was contracted to apply internal and external corrosion prevention coatings to internal and external field joints during the construction of a 36 in. nominal pipe size

Table 1. Onshore/offshore corrosion prevention project	
Onshore location	Port of Amsterdam, Amsterdam, the Netherlands
Offshore location	North Lincolnshire, England
Purpose	Clean, coat and inspect internal and expernal field joints for coating as corrosion prevention
Pipe facts	36 in./4.5 km
Weld data	301 internal and expernal field joints were cleaned, coated and inspected
Coating	Sigmaline 2000, internally and externally

Figure 1. This automated liquid coating system reaps environmental benefits with an overspray recovery box that captures approximately 95 - 99% of fugitive emissions.

(NPS) replacement pipeline that was used to transport crude oil from tankers to an existing onshore transfer pipeline. The oil is then stored in a terminal until it is needed in the refinery. The customer's existing subsea line had reached its serviceable life, and the replacement pipeline is anticipated to last for 40 years. This longevity will be due in part as a result of designing the pipeline with corrosion prevention at the forefront. The internal and external field joint coatings provide seamless surfaces that strengthen the integrity of the pipeline before any product flows.

This unique onshore/offshore project was the first co-coating project for ACS. It was also the first time CRTS coated internal field joints with a liquid coating, while an external field joint liquid coating was being applied simultaneously. CRTS frequently coats internal field joints with a FBE coating with simultaneous OD FBE coating operations. ACS had seven employees on site to accomplish the project on time.

The coating activities were first performed in a string yard located in the Port of Amsterdam and completed onboard a string barge in northern England. The entire internal field joint coating process was performed using the CRTS remotely controlled robotic line travel equipment. The external field joint coating was performed by the customer's vendor and CCSI field services.

Proper surface preparation

Having a properly prepared foundation for the coating application should not be underestimated in effectively preventing corrosion. A surface profile was established by blasting the internal pipe ends to NACE 2 (SSPC-SP10/Sa 2 1/2) before welding. For quality assurance purposes, no work was performed by ACS on either internal or external field joints until the welds were in an acceptable condition. For instance, if an internal weld bead's profile did not meet ACS' stringent quality standards, the weld was dressed and then inspected visually by CRTS before being released for coating. CRTS standards for an internal weld profile include: free of weld spatter, no sharp edges, porosity, weld flux, 1.5 mm height, and other quality measurements. The redundant inspecting, dressing and re-inspecting of the welds had the potential to delay the entire production process. However, rather than cause delay, these extra steps ensured a defect-free coating.

Part one of the coating formula to prevent corrosion is preparing the surface for coating, because the coating alone cannot provide the protection needed for longevity if it cannot adhere to the joints. Despite widespread knowledge and education available for proper surface preparation, it remains one of the most common reasons for coating failure.

A crucial factor before coating is prepping the pipe's field joint surfaces, including eliminating electrolytes (inside and out) and creating a surface profile. The surface profile determines whether or not the coatings will adhere properly. For an internal field joint coating, the cleaning process ensures the weld meets NACE 2 (SSPC-SP10) specifications after welding/inspection, and creates a profile on the fresh weld metal. ACS used CRTS line-up cameras to locate each internal field joint, and then robotically cleaned it with abrasive grit. The vacuum unit then reclaimed the grit for recycling, and the onboard camera helped the operator ensure all of the abrasive grit was removed.

The external field joint blasting was performed using the CCSI external blast ring and blast recovery system (BRS) units. These units also incorporate recycling devices to help ensure there are no impurities left on the welded surfaces. The BRS units also reduce customer costs by recycling the blast media and reusing it on the next field joint.

Proper protective coatings

Another important component of the corrosion prevention formula is to select the proper coating for the pipeline's purpose. While there is no perfect method, selecting the proper protective coating for the pipeline's purpose is absolutely vital to creating a defect-free internal surface. The same principles apply for external field joint coating. ACS tested Sigmaline 2000 (the coating selected by the customer) for compatibility with ACS equipment in Saudi Arabia and the Netherlands, as the coating is not available in the US.

The benefits of coating a new pipeline's internal field joints include:

- Increasing pipeline longevity.
- Reducing internal corrosion.
- Reducing pipeline flow friction.
- Reducing pipe wall thickness requirements.
- Diminishing or eliminating pipeline leaks.
- Protecting environment from leaks, ruptures or spills.

The accepted method of applying protective coatings to internal field joints has a demonstrated 10 - 20% increased throughput as a result of reduced friction. Maintenance is reduced because less rust is in the pipeline.[3]

The benefits of coating the external field joints with liquid coating include:

- The ease of application in low temperatures.
- It can be applied where FBE coatings cannot.
- Liquid coatings do not interfere with cathodic protection methods of corrosion prevention.

Phase one of the project began at the contractor's string yard in the Port of Amsterdam. The pipe strings were preblasted, welded and weld-inspected by subcontractors before ACS coated and inspected the internal and external field joints. Also, the heat shrink sleeves were applied and the pipes received concrete infill. After the strings were loaded onto a barge and sailed to the refinery, phase two began. In total, there were 43 strings of seven welds (100 m) each.

ACS brought customised equipment to the project, including CCSI induction heating rigs, an external automated liquid coating ring, and CRTS robotic cleaning, coating and inspection equipment for the internal corrosion prevention process. The crews found it essential to work closely to achieve the highest quality internal and external coating results for the customer.

Coating challenges

On paper, the project was ideally planned for the existing environment. However, in reality, northern Europe's extreme weather forced everyone to rethink, revise and recalculate coating methods. Although the coating manufacturer had a reasonable temperature range for the coating application, the simultaneous processes of heating, applying coating and maintaining the heat to allow curing proved extremely difficult as ACS crews and customer crews were inundated with constant wind, rain and ice storms. The customer can be assured that weather

Figure 2. The robotic cleaner ensures a surface profile that the coating will adhere to, providing seamless corrosion prevention.

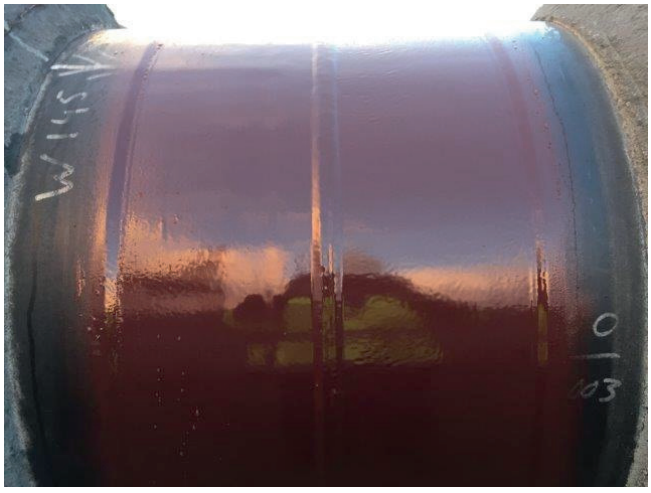

Figure 3. Coating external field joints assures seamless corrosion prevention.

delays are offset by the delayed onset of corrosion in its pipeline.

Many mornings dawned with high humidity, forcing the field technicians to wait until well after sunrise to begin the cleaning and coating operations. The excessive humidity can result in flash rust on the pipe, possibly leading to premature coating disbondment. These weather conditions made the pace of production difficult for all crews.

Coating the internal and external field joints proved demanding using the 'pre-heating and force curing with induction heating' method. As recommended by the manufacturer, the coating was applied when the pipe surface temperature was between 5°C and 60°C to avoid sagging after application.

Unfortunately, the results were not ideal under the complex circumstances. If the pipe temperature rose above 45°C when the coating was wet, it would run, making the force curing very difficult because it took longer than expected to cure each weld. Rather, the pipe temperature was maintained for 30 mins. at or below 45°C after application. If there was not enough heat on each coating band before the day ended, there was a high risk of the paint not curing overnight in the cold temperatures. If the paint did not cure, an amine blush formed in the coating as it absorbed moisture overnight.

An amine blush "may cause low hardness, poor paintability, poor intercoat adhesion, water spotting, poor solvent resistance, and/or poor gloss retention and white solids formation,"[4] any of which could undermine corrosion prevention. Despite the unpredictable conditions, the sister companies worked diligently and successfully found a solution that met the customer's needs.

Because this was not a typical lay barge formation, a new set of challenges were presented once the onshore portion of the project was complete. The project required cleaning, coating and inspecting 100 m tie-in sections. All of the processes had to be completed in the same welding/coating area: pipe pull, pipe line up, welding, weld inspection, coating, coating inspection, shrink sleeve and end fill processes were in very close quarters. An example of the special circumstances was the need to move the CRTS robotic equipment train for internal field joint coating from one position to another, without interfering with other lay barge processes and crews. To overcome this issue, a specially built trough (launcher) on wheels manoeuvred the equipment into position, and was then removed after completing its functions on each weld. It could take anywhere from 8 - 18 hrs to complete each weld. Despite the unusual setup, the lay barge production phase went very well for ACS and the customer.

The internal and external field joint coating application specified by the customer demonstrates the importance of corrosion prevention management at the earliest stages of designing a pipeline for a long life. Overall, ACS cleaned, coated and inspected 301 mainline welds over 11 weeks in a string yard in Amsterdam Harbour, completing phase one in a string yard on schedule. Phase two was completed on time after coating 42 tie-in joints on the offshore string barge from the existing onshore pipeline to the PLEM offshore. The sum of this formula will equal unparalleled corrosion prevention for the life of this pipeline.

References

1. https://primis.phmsa.dot.gov/gasimp/docs/FinalReport_PipelineCorrosion.pdf
2. "Control of Internal Corrosion in Steel Pipelines and Piping Systems," NACE SP0106-2006.
3. Protecting pipe: the importance of selecting the right coating, 2011. Retrieved from http://pipelinesinternational.com/news/protecting_pipe_the_importance_of_selecting_the_right_coating1/063320/
4. BURTON, B.L. Amine Curing of Epoxy Resins: Options and Key Formulation Considerations, Paint and Coatings Industry Magazine, June 2006, pp 68 - 77.