JAMES A. HUGGINS AND CAROLINE A. FISHER, CRTS, INC., USA,
EXPLAIN HOW INTERNAL COATINGS ARE THE SOLUTION TO THE INTERNAL CORROSION PROBLEM.

THE INSIDE TRACK

Leaks, spills, repair cost, remediation cost, environmental damage, loss of pipeline productivity, bad press, reduced lifespan. Clearly, internal corrosion has a domino effect. Let's put away the dominoes and do something revolutionary: build a different style of pipeline. First, coat the inside of the pipe with a high quality epoxy resin. Then, coat the internal field joints. CRTS, Inc. (CRTS) provides this cost-effective, revolutionary solution.

Many pipeline companies use coupons, periodic inspection, formulaic wall loss calculations and flow monitoring to assess the severity of localised corrosion and develop a 'repair or replace' protocol. However, internal coatings can help prevent the corrosion from happening – period. This prevention is possible by applying protective coating before the pipeline is placed into service. Protectively coating the pipe does add some overall cost to the project, but it also provides tremendous benefits to people, the environment and energy companies alike.

CRTS, the designer, manufacturer and service provider of internal robotic coating equipment, recently completed two offshore water injection projects for a respected international energy company. The projects provided a unique and first-time challenge for the CRTS' engineers and field technicians: inline inspection of internally coated field joints immediately following the coating process. The 813 welds coated and inspected on Project A, along with 1477 welds

Figure 1. Pipes standing ready for internal cleaning, coating and inspecting on Project B's laybarge.

coated and inspected on Project B, bring CRTS' total coated weld count to more than 110 000.[1] The international energy company is similar to other customers who also understand how vital corrosion protection is to oil and gas, minerals and mining and water and wastewater infrastructure. After all, once corrosion begins, "it can propagate rapidly, it is difficult to inspect, and it can lead to other failure modes such as stress corrosion cracking and corrosion fatigue."[2]

CRTS' customers are interested in pipeline longevity, eliminating environmental risks and enhancing product flow (business aspects aside). In the past, industry has comfortably relied on corrosion inhibitors, sacrificial wall, good luck, etc., but the benefits of protective coatings exceed these costly measures. Since internally coating field joints adds a relatively low overall cost while achieving a high ROI, many pipeline owner and public interest objectives can be met simultaneously, as shown in Table 1.

Table 1. CRTS bridge between pipeline industry and the public

Pipeline owner interests	CRTS bridge	Public interests
Safe transportation, sound investment, brand name protection, risk management	Revolutionary robotic technologies for applying protective coatings	Consistent fuel supply, environmental sensitivity, brand trust, personal safety

Table 2. Case study projects in a nutshell

Pipe diameter	12 in.
Wall	0.825 in.
Length	9.7 km internal and external FBE
	19.2 km internal FBE
Coating	Akzo Nobel Resicoat 726
Welds coated	2290 (Project A – 813; Project B – 1489)

Figure 2. A train of robotic equipment enters a string of pipe to internally coat part of Project A.

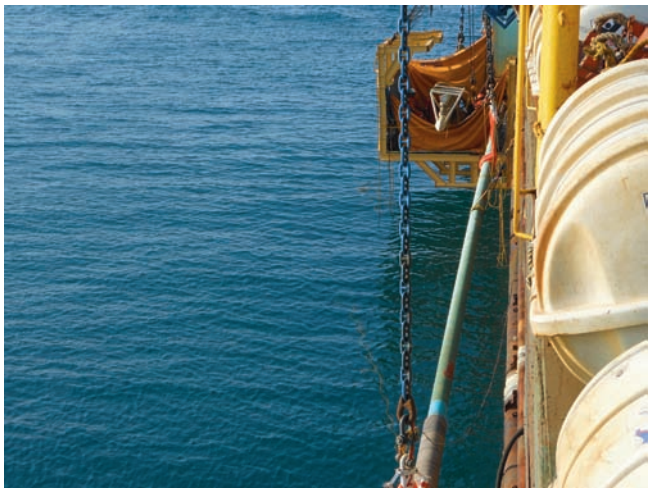

Figure 3. CRTS is able to meet the challenges of offshore projects, including tie-ins such as those on Project B.

Offshore challenges

Offshore projects are associated with many high risk factors such as maritime accidents, high installation and operation costs, life support systems, specialised safety training for personnel and exposure to nature's extreme elements, to name a few. Offshore projects also bring the usual pipeline design parameters, including the product's corrosive tendencies, atmospheric conditions (water, temperature, humidity) and pipeline mechanical design complicated by offshore construction techniques. Engineers design pipelines based on the owner's desired lifespan. Without protective coatings, that lifespan is difficult to achieve. For the case study energy company's projects, the challenge of achieving the desired lifespan has been met with up-front, preventive protection amortised in 3 - 5 years of additional life.

Case study

CRTS worked with project managers at the international energy company to ensure the most compatible and efficient methods of corrosion protection for the company's pipeline investment. These projects were located in shallow but rough waters of the Atlantic Ocean.

In 2004, CRTS made its initial presentation on its internal field joint coating technology to the customer. In 2008, the customer's corrosion specialists and engineers developed an internal company specification outlining the process and acceptable variables. The customer's inspection process in Tulsa was then passed during a pre-production test. Then, in 2009, CRTS began coating internal field joints for the 'onshore' portion of Project A, culminating in 2012 with the offshore water injection pipeline portions of Project A and Project B. Initially, the internal field joint coating application was expected to be critical path. In practice, the process was critical path on only two of the 2290 coated field joints (Table 2).

Offshore laybarges are outfitted with stations for welding, inspection and coating. CRTS' standard procedure is as follows: When the pipe enters the ready rack, the contractor completes its field joint pre-cleaning using a Vacu-Blast style abrasive cleaning machine that prepares the 2 in. internal cut backs. The cleaner/coater/inspection robot is located at station 7, just past the NDT station. After a weld passes NDT inspection, the company's robot moves into place and is triggered.

Both Project A and Project B required two 12 hour shifts, seven days a week with eight field technicians and a project supervisor. A field technician was stationed in the bead stall, where the TIG ROOT welding was performed. An inspection

Figure 4. This photo from a separate project portrays the typical configuration of the pipe on the laybarge in similar work conditions.

device was also positioned on the line-up clamp to verify the root bead surface profile quality.

The company's cleaner unit is comprised of a robot that throws steel grit onto the field joint circumferentially, cleaning and abrading the surface. Especially important is imparting anchor profile in the fresh weld bead metal. The steel abrasive grit is then vacuumed, filtered and recycled, ready to clean the next field joint.

At station 7, another technician controlled the external induction coil that heated the pipe for the fusion-bonded epoxy (FBE) coating application. This process is required for FBE coating internally and externally. When the pipe reached the coating manufacturers' recommended temperature, the FBE coating cycle was started. Performing internal and external coating simultaneously improves total cycle time.

The inspection process is the key to protective coating integrity. It is one of CRTS' most vital services. The offshore robotic train configuration consists of a crawler, battery cart, cleaner, vacuum, coater and, for these projects, the energy company requested an inline inspection device. Incorporating robotic holiday inspection and dry film thickness readings allow for immediate qualitative results.

Another field technician viewed all robotic functions, including the inspection cycle from his remote location, via monitors. He simultaneously recorded cleaning, coating and inspection video for the customer. This live feedback means any time the applied coating is not up to the thickness specified, has a holiday or other anomalies, these issues are corrected inline before progressing to the next field joint. For instance, a high quality smooth profile on the internal weld bead will alleviate those anomalies as failure modes.

Internal field joint coating is much better than no coating, but holiday inspecting ensures a higher level of coating integrity. Therefore, a higher level of corrosion protection can be achieved using internal robotic inspection equipment. CRTS is 100% committed to providing this key service at customers' request.

In summation

If a pipeline is left uncoated, the only recourse for internal corrosion protection is to cross your fingers or spend additional monies using pigging devices and corrosion inhibitors after the corrosion has most likely begun. Internal corrosion's domino effect is a dangerous game for many pipeline owners. An Alberta, Canada study released in June 2009 demonstrated that 39% of Canada's operating pipeline failures were due to internal corrosion.[3] The study is representative of many common corrosion issues, and addresses many of CRTS' customers' past corrosion problems. CRTS addresses these issues with its innovative robotic technology and coats internal field joints not only to protect assets, but also to:

- Save energy costs.
- Improve transportation infrastructure.
- Reduce pipeline friction.
- Lessen environmental impact.
- Eliminate corrosion allowance.

These five points only hint at their significance to the pipeline industry. Saving energy costs leads to lower prices for private and commercial sectors. Reducing pipeline friction enhances product flow and further reduces transportation energy costs (compressor usage and pipe diameter minimisation). Lessening the environmental impact reduces iron ore mining and processing, as well as extends the pipe's useful life. Eliminating corrosion allowance allows the customer to reduce the pipe wall thickness, further reducing pressure on iron ore, steel production and reap significant savings.

The international energy company has arguably chosen the most reliable method possible to avoid leaks caused by internal corrosion for its onshore and offshore water injection projects. There are many companies who have benefitted from the company's onshore protective coating application technology, but this case study and similar offshore projects stand out due to the staggering difference in costs and environmental risks involved in offshore pipelines. CRTS continues to help reduce customers' annual cost of ownership by providing this essential coating service with unique robots operated by specially trained field technicians.

In keeping with its commitment to meeting and exceeding customer needs, CRTS uses processes that comply with its ISO 9001:2008 quality system. The company also has nearly a dozen R&D projects that it expects will significantly impact its onshore and offshore services through enhanced electronics, video and robotics. Several of these projects have prototypes that are expected be developed in the next year. WP

Notes

1. This number does not include current CRTS projects.
2. 'Corrosion Life Prediction', *Southwest Research Institute*, http://www.swri.org/4org/d18/mateng/corr/lifepred.htm (Accessed on 29th of October, 2012).
3. 'Mitigation of External Corrosion on Buried Pipeline Systems', *Canadian Association of Petroleum Producers* (June, 2009).