FAMILIARISING the *unfamiliar*

Figure 1. Polyguard RD-6 being applied by a local contractor.

Luc Perrad, Polyguard Products, Belgium, discusses how a non-shielding coating is being introduced into the European and African pipeline markets.

While differentiation can shock those who are familiar with standardisation, it is the key to innovation. If manufacturers are not innovating, they are merely competing in a commoditised market on pricing. Eventually, in many cases, quality decreases as price takes over as a dominant factor. The purpose of this article is to demonstrate that a differentiated coating system can be more advanced in its design.

Polyguard specialises in products that protect surfaces and structures from moisture, water and other undesired substances. In 1988, Polyguard's pipeline division introduced the Polyguard RD-6 (RD-6) pipeline coating to the US market. It is the first pipeline coating to address the problem of cathodic protection (CP) shielding and is a wrapping material that comprises a continuous layer of cold-flowable rubberised bitumen, bonded to a non-elastic polypropylene mesh backing.

While the RD-6 coating has been, and is still, successfully used in the North American market, it is now also available worldwide. Since 2014, RD-6 has been being introduced into the Western European market along with key countries in Africa.

Introducing RD-6 to these markets has been particularly challenging because they are driven by European and ISO standards. These standards refer primarily to polyethylene (PE) materials, which the RD-6 coating does not contain.

The German Deutsches Institut für Normung (DIN) was one of the first organisations to publish standards in Europe. In 1975, DIN was made the national normalisation institute to represent German interests at European and international levels. Its standards, such as DIN 30670 for main line coatings and DIN 30672 for field applied coatings, are specifically fit for extruded PE and cold or hot applied PE tapes and shrinkable materials.

The European Committee for Standardization publishes European norms (EN). For field applied coatings, EN12068 (published in August 1998) is largely based on the requirements of DIN 30672. Similar to DIN 30672, EN12068 standard fits perfectly for PE materials.

In December 2008, the International Standard Organization (ISO) published the first international standard for field joint coatings (FJC): ISO21809-3. Re-published in March 2016, this standard includes 11 FJC 'types'; tapes (bituminous, wax, polymeric, viscoelastic), heat shrinkable materials, liquids, flame sprayed etc. Each coating type has its own requirements. For polymeric tapes (PE tapes) and PE heat shrinkable sleeves, the requirements are mainly based on EN12068. However, ISO21809-3 does not include a coating type like 'cold-flowable rubberised bitumen bonded to a non-elastic polypropylene mesh backing', which RD-6 would fall into.

RD-6 largely outperforms the requirements of the standards mentioned above that are used in Europe and North Africa. It has good adhesion on steel and line coatings (even after hot water immersion), high cathodic disbondment resistance and enhanced lap shear (soil stress) resistance due to the high tension that is applied to the mesh during application and approximately 400% higher tensile strength.

Polypropylene has different elongation properties and ratios to PE. In fact, lower elongation is often preferred as a mechanism against soil stress.

However, despite its high performance, RD-6 cannot be EN12068-approved because it does not meet its requirements. In a peel test, after 100 days of ageing in a dry oven, the standard requests 75% residual peel force. However, the typical result for RD-6 is 60%. It is important to note that this ageing test comes from the old DIN standards and fits perfectly for PE materials.

For the ISO21809-3 standard, only polymeric (PE) and viscoelastic tapes, and PE shrinkable materials require a peel test after ageing in an oven. All other coating types do not need to undergo this specific test as it is not relevant for materials that are not PE.

With regards to conforming to ISO21809-3, Polyguard has been working with the relevant ISO group for two years to include an additional coating type called 'polymeric mesh backed coating' in the standard. This procedure should take a couple of additional years.

Figure 2. Holiday detection at 10 kV.

Peel testing in Europe and Africa

Despite its 'non-compliance' to the requirements of EN12068 and ISO21809-3, more and more pipelines operators in Europe and Africa have seen and understand the value of the RD-6 coating. They have, therefore, opened their doors to evaluate it.

One of the first pipeline operators to test Polyguard's coating on the field was Fluxys Belgium. In December 2014, RD-6 was applied on a 6 in. pipe, including the weld bead and overlap onto PE parent coating.

Seven months later, the pipe was excavated and the coating was tested. Holiday detection (15 kV) was followed by peel tests on PE (3 - 4 N/mm) and steel (4 - 8 N/mm). Only the mesh came off, while all of the rubberised bitumen stayed on the substrate.

Sumed Egypt (The Arab Petroleum Pipelines Co.) owns and operates twin 42 in. crude oil pipelines of 319 km long. Originally laid in 1974, the pipelines were coated using PE tapes. The PE tapes had suffered deterioration and ageing.

In May 2015, Sumed Egypt organised an application trial of the RD-6 on a 12 in. pipe, together with PE tapes. The tests were conducted 24 hrs after application and these convinced Sumed Egypt of the quality of Polyguard's RD-6 coating. In terms of adhesion, the average peel resistance of the coating was 4 N/mm, compared to 2.6 - 2.8 N/mm for the PE tapes.

After the testing, Sumed Egypt modified its technical specifications by changing its reference standard from EN12068 to NACE SP0109-2009, which RD-6 meets the requirements for.

RD-6 can perform well on wire brushed surfaces. In April 2015, Air Liquide tested the adhesion of RD-6 on a wire brushed steel surface quality (St 2 - St 3). Five months after application, the peel force recorded was 6 N/mm. The same piece of pipe had been peeled by Open Grid in Germany in September 2016 with the same value.

In January 2016, peel tests were conducted at Exova UK. The steel surface quality was St 2 at Sa 2 ½ standard with 100 mg salt contamination. The PE surface was 23˚C at 10 mm/min.

The tests conducted at Exova UK suggested that RD-6's adhesion test need to be conducted at high speed (300 mm/min) in order to evaluate the adhesion of the coating on the substrate. The NACE SP0109-2009 requirement is 3.5 N/mm, while ASTM D1000 requires 300 mm/min.

In September 2015, RD-6 was applied on an in service 10 in. pipeline that was operated by Sonelgaz DRTG. The application conditions were particularly difficult. It had poor surface preparation (St 2 - St 3) and constant humidity (moisture) on a large part of the steel surface. This was because the area needing coating was located just after a decompression station with important gas flow at temperatures close to 0˚C. Even the use of a torch could not keep the steel surface dry during this application of RD-6.

Before backfilling, the coating was tested using a holiday detector with a potential of 15 kV. Six months later, the pipeline was excavated for inspection. Visual inspection and holiday detection showed a perfect general appearance of the coating: no disbondment, no delamination, no wrinkles and no holidays. In fact, the coating looked as new, despite the application conditions.

An adhesion test conducted on the overlap area with a coal tar enamel (CTE) parent coating showed strong adhesion and no disbondment between the RD-6 and CTE. An adhesion test conducted on the steel surface showed poor adhesion on areas where the RD-6 had been applied on wet surfaces and strong adhesion elsewhere.

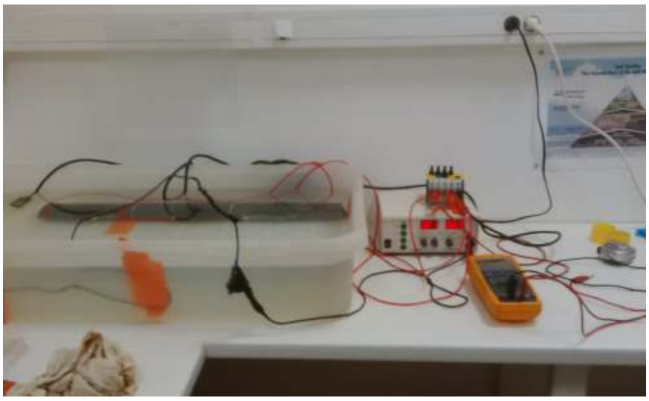

Figure 3. General overview of the testing in Ingeca's laboratory.

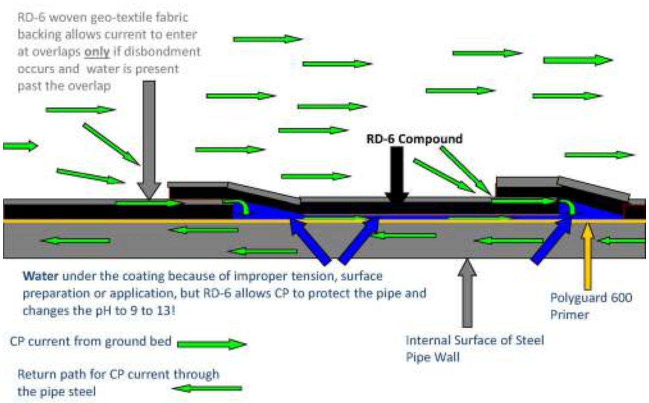

Figure 4. CP current (green arrows) can reach through the overlap under disbonded RD-6.

Even with the poor adhesion of the RD-6 when applied to wet surfaces, the coating showed excellent appearance with no defects after six months in the soil. This is primarily due to the high tension applied by the wrapping machine during application. Due to its reduced elongation and high tensile strength resistance (approximately four times that of PE tapes), RD-6 is wrapped with much higher tension. Polyguard's coating firmly encloses the circumference of the pipe by contracting after application, which secures the cohesion and integrity of the coating.

Sonatrach is the national oil and gas company of Algeria. With a total length of 19 600 km of transportation pipe that range between 20 in. and 48 in. dia., Sonatrach is the largest oil and gas company in Africa. As part of a pipelines rehabilitation plan, RD-6 was demonstrated on a 28 in. operating section pipeline in March 2016. Field tests were also conducted:

- Holiday detection at 10 kV: no holiday.
- Thickness test: 1.2 mm on single layer and 2.3 mm on double layer.
- Adhesion test: 5.6 N/mm.

In Croatia, application demonstration conducted on a 20 in. pipe in September 2015 convinced Plinacro of Polyguard's RD-6 coating quality. Moreover, Open Grid Germany decided to test the material on an 8 in. pipe at its laboratory in Essen in September 2016. The tests are still underway.

Pitting corrosion due to shielding coatings

The non-shielding property of RD-6 has attracted many pipeline operators, in both North America and, more recently, Europe.

A 'shielding coating' is a coating that protects CP current from the electrolyte to the steel. This happens when the shielding coating disbonds (lifts up) from the steel and insulates the CP current from the non-coated steel. Anodic and cathodic points develop under the disbonded shielding coating, resulting in pitting corrosion at the anodic points. The water under the disbonded shielding coating becomes acidic due to the corrosion reaction (typically a low pH of 4 - 6).

Pitting corrosion is, arguably, the most critical corrosion phenomenon because it develops in localised areas, resulting in leaks by punching the steel.

According to the US Pipeline and Hazardous Materials Safety Administration (PHMSA), typical examples of shielding coatings are PE tapes, shrink sleeves, coal tar mastics and asphalts. These coatings can prevent CP currents from reaching the pipe when they disbond from the pipe's surface. It is also important to note that field applied coatings are much more likely to disbond from steel due to the following reasons:

- Ambient conditions during application are not 100% controlled (temperature, humidity and due point).
- Surface preparation on the field is not controlled as it can be in the plant (steel profile and salt contamination).
- Most of the coating applications are manual rather than automated, which results in some defects.

In North America, there is concern regarding cathodic shielding problems. Standards, such as NACE SPO 169-2007 and the US Code Federal of Regulation's 49 CFR 192.461, 195.551 and 192.112, prohibit the use of shielding coatings. Moreover, many pipeline operators have complained about pitting corrosion due to the use of shielding coatings. However, the non-shielding property of RD-6 is illustrated in Figure 4.

Its woven geotextile fabric (mesh) backing is conductive and allows CP current to enter under the disbonded coating at overlap areas. This can only happen if disbondment occurs with water present past the overlap.

To demonstrate to pipelines operators that its RD-6 coating does not shield CP current, Polyguard conducted laboratory tests with Ingeca. Stated below is the test method and the results of the testing.

In October 2015, three 30 x 40 mm steel coupons were installed on a PVC pipe and coated using RD-6. An overlap area was left just above each coupon. Coupons 1 and 2 had been coated with intentional RD-6 disbondment, leaving a void filled with water between the coupon and the coating. Coupon 3 was properly coated without void between the coupon and the coating.

Contrex commercial water with following salt composition was injected under the disbonded RD-6 coating: Ca: 468 mg/l; Mg: 74.5 mg/l; Na: 9.4 mg/l; SO: 1121 mg/l; HCO: 372 mg/l. The PVC pipe was immersed in the same commercial water and no additional salt was added.

Two additional non-coated steel makers were used. One marker was in the same electrolyte and container as the three coated coupons (same CP protection), while the other was in the same electrolyte but in a different container from the three coated coupons (no CP protection).

Tests were conducted for three months. After this period and once the RD-6 coating had been removed, no corrosion was observed on coupons 1, 2 or 3.

The original pH of the electrolyte (commercial water) was 7. The uncoated marker with CP was covered by calcareous sediment after chemical reaction due to CP current. The pH tested on the surface of the sediment was 12. Under the disbonded RD-6 coating on coupons 1 and 2, pH 12 was also measured. The uncoated marker without CP was covered in rust. The pH levels on the surface of the rust was between 6 and 7. Finally, since there was no water under coupon 3, no pH was measured on this coupon.

The tests were convincing. A presence of current was measured on each coupon, visual inspection after three months showed no corrosion under any of the coupons and pH 12 was measured under disbonded RD-6. Thus, it can be drawn that a polymeric mesh backed coating, such as Polyguard's RD-6, does not shield CP current.

While Polyguard's RD-6 coating system does not align with all of the European standards and is not included in ISO21809-3, both the European and African markets are showing more and more interest in this coating system for many reasons. These reasons include RD-6's high basic performance (adhesion, soil stress and cathodic disbondment resistance) even on poor surface preparations, its non-shielding properties, and its ability to be quickly and easily applied.