INNOVATION IN THE FIELD

Drs. JF Doddema, and ing. E. Broesder, Stopaq Europe B.V. , The Netherlands, analyse anti-corrosion systems and discuss the use of visco-elastic self-healing anti-corrosion coatings in combination with a shrinkable sleeve.

Modern pipeline maintenance and new construction of pipelines requires advanced corrosion protection systems in order to prolong service cycles and to ensure reliable and sustainable operation features. It is clear that there are thousands of miles of corrosion protected pipelines which, for decades, have done their job. The question therefore arises: is it correct and fair to say that the existing pipeline corrosion protection systems generally do not fail? Is there room for innovation in the field of pipeline corrosion protection, if the statement mentioned before is correct?

Limits of current anti-corrosion systems:

Looking closer at pipeline maintenance projects, you will find some particular failures and incidents, which can be classified as follows:

- Mechanical damages.
- Soil creep and stress.
- Tenting or bridging at seam welds.
- Cracking.
- Poor application.
- Cathodic shielding.
- Osmosis and MIC problems.

If you start to dig into this topic you will find more and more corrosion prevention failures related to the chosen coating system. Having analysed the various kinds of failures, one question comes up: 'Why do anti-corrosion systems fail?'

Let us approach this topic by proposing the following hypothesis: 'Whenever you apply an anti-corrosion system you add extrinsic properties'. These features are attached to the system in order to fulfill the obvious requirements.

Here are a few examples.

Many protective coatings rely on the function of cross-linking. In order to make the 'coating system' work, a chemical crosslink reaction is required. The system adds mechanical stability and stiffness to the applied coating material. It is an extrinsic property of the applied coating.

For instance, regular anti-corrosion tapes require 50% overlap and machine application. Why you have to do the overlap? The tape itself will protect against corrosion, but are you sure that the 'system' will work for long-term protection? The overlap of the tape is an extrinsic property in order to improve the performance of the material at the edges.

Another example is polyethylene-shrinkable sleeves. It

is definitely an extrinsic property when you apply heat to your shrink sleeve in order to reduce the distance between the protective layer and the substrate. It is an extrinsic property.

What is the target for adding this extrinsic property?

The answer is simple: the protective layer has to be hard, unbreakable, impermeable and durable. Having analysed the relevance of extrinsic effects, let us ask the question once again: Why do the anti-corrosion coating systems - even to a very low percentage - fail?

In many cases the extrinsic properties of corrosion protection systems fail!

Innovative, amporphuos viscous-elastic anti-corrosion material based on poly-isobutene

This is the starting point of the idea to use viscous elastic material as innovative anti-corrosion system. The selection was based on the fact that the polymer should already contain a sufficient set of intrinsic properties.

Poly-isobutene has proven to be the material of choice. There are only covalent bonds and the polymer just contains the elements hydrogen and carbon. The polymer chain cannot be cross-linked and will remain for the whole life-time as single polymer chain. This structure leads to an interesting effect: the cold flow. Even at very low temperature the poly-isobutene will over time, fill into all pores and structures of the substrates like steel, PE, PP, epoxy coated, de-rusted steel etc.

Macroscopic properties of poly-isobutene based coatings

The material will permanently remain soft and tacky. At the same time, it will remain resistant against weathering, chemicals and stay impermeable for moisture, air and bacteria. These properties will be sustainable in the pipeline temperature range of -45 to +120 ˚Celsius.

The adhesive strength of the material will be in the same range as the cohesive strength. Whenever you try to remove the coating in a wrap form, a certain portion of the coating material will always fully remain as a film on the surface of the metal pipe substrate.

The new viscous elastic coating gives end-users looking for pipeline rehab and new construction pipelines much stronger physical properties, providing the end-user

Figure 1. STOPAQ'S training centre.

Figure 2. Application of shrinkable sleeve over Stopaq's Wrappingband CZH.

with longer investment; less maintenance and reduced costs over time; reduced instance of damage during service due to self-healing propertie; highest levels of corrosion resistance; higher levels of chemical resistance; higher process temperature ranges; faster and easier application and installation without need for special equipment and operator skills (even at freezing conditions); better field joining methods; and above all lower surface preparation and application costs.

Stopaq's field joint coating system

Field joint coatings have become an important but sometimes weak link in the corrosion protection of pipelines. Heat shrinkable sleeves are now the industry standard and have been used successfully but have also caused specific problems. The success of shrink sleeve technology relies on many factors such as surface cleanliness, pipe and sleeve temperature, adhesion to the factory coating. All these parameters depend largely, if not completely on the operator's skill and experience. Improvements have been made in time by using epoxy primers but in some circumstances, e.g. in cold climates, good application is still difficult.

Once a shrink sleeve fails to adhere for 100%, or looses adhesion in time due to soil stress, there is a risk of moisture penetrating under the sleeve, causing corrosion. The minor leaks will in time pass enough water to cause corrosion, but have a high resistance for cathodic protection current. Therefore, cathodic protection will not be able to protect the steel under the disbonded sleeve and the established survey methods (CIPS/DCVG) will not be able to detect the anomaly as a serious threat to the pipeline.

A new system has been introduced that combines the (mechanical) strength of a shrink sleeve with the well known viscous-elastic anti-corrosion properties. In this system, the functions of corrosion protection and mechanical stability are separated and the quality of each of these functional components can be checked separately. A 2 mm layer of the viscous elastic wrappingband is applied on the field joint area; it adheres to all substrates without pre-tensioning. The cold flow technique makes the material flow into the smallest pores, even in cold climates. Once applied, it will remain elastic and will not disbond. After the application, the system is 100% holiday tested using 15 kV to ensure a flaw-free corrosion protection which can be guaranteed for 30 years.

After the satisfactory application of the anti-corrosion layer a 2 mm shrink sleeve is applied for mechanical stability. Although the shrink technique is the same, the application is easier and less critical. The pipeline does not require pre-heating and the first layer acts as a thermal insulator allowing a consistent and uniform shrinking process. In cold climates, the slight heat input enhances

the micro flow of the anti-corrosion layer.

The adhesion of the shrink sleeve to the factory coating is important for the mechanical stability of the system, however, if the sealing is not 100%, water might penetrate under the sleeve and the viscous elastic layer will continue to provide full protection. Cathodic protection under the sleeve is not necessary because of the impermeability of the first applied layer. Any micro organisms or SRBs that might develop under the sleeve will not affect the pipe or anti-corrosion coating.

Figure 3. Stopaq containers along the roads in the northern Part of the Netherlands.

The extra material cost for this system is higher per square meter, however, substantial savings are made on personnel and mobilisation costs, e.g. on blasting equipment, blasting grit clean-up, induction heating equipment.

How this visco-elastic coating worked on the Dutch North-South Pipeline

Let us have a look at how the intrinsic corrosion protection properties work in the field.

The surface preparation of the metal pipes is very simple. Make sure that the substrate is clean and dry. Marginal surface cleanliness is required. The minimal surface cleanliness (St 2/3 clean and dry) and surface profile is not an issue while other systems may require near white metal finish (Sa-2-1/2) and a surface profile of at least 75 microns. There is also no necessity to use a primer such as 2 component epoxies. The application temperature starts at -30 C and can be extended up to + 50 C. This is not limited by the material, but by the working conditions of the applicators. Due to the fact that the material is soft and has very strong adhesive strength to the metal pipes, there is a “self-healing” effect. It is in the nature of the material that is non-toxic. The high strength ensures that no cathodic disbondment or under creep is possible. The adhesion remains permanent and starts immediately without any chemical reaction. At the moment, the North-South Netherlands Pipeline is protected by the Stopaq Fieldjoint Coating system consisting of Stopaq Wrappingband CZH and Stopaq High Impact Shield. 22 000 joint is the first phase. The advantage of this two layer system is bclear for local contractors:

- No curing time. The new system does not require any waiting time before backfill after its application/ installation while liquid coating requires at least one day to cure properly after application before backfilling. During the cold months, the waiting time for liquid coating to cure properly could take days. Obviously, it will be a decrease in cost for at least one day, which translates to elimination of the cost of manpower, equipment and utilities.
- Less drainage time. As a result of no curing times, the time needed to perform the rehabilitation work will be significantly less, making the cost of water drainage much less in return.
- Less drainage cost. Since the time of excavation until backfill requires water drainage to remove water from the bellhole (excavation), the drainage cost is significantly higher in the application of liquids because

Figure 4. Stopaq, Stadskanaal, The Netherlands.

of the curing time.

- Manual installation. The application does not require costly equipment. It is installed manually in most cases. For liquid epoxy coating, tapes or shrinkable sleeves, equipment such as air compressor, spray equipment, air filters, tape machines, induction heater and manifolds are used. Furthermore, these equipment and machines need maintenance and spare part replacement, that adds up to the cost.
- Less skilled manpower. The application does not require highly skilled manpower. All workers are trained by Stopaq Europe BV and examined at the in-house training centre of Stopaq Europe by Pipeline operator examiners. This means that with little training on the job, the job can be done. This mostly also implies the benefit of lower labour cost.
- Holiday Test and Repairs are not a requirement. Holiday tests are normally not needed. The viscous-elastic anti-corrosion material is delivered as prefab in 2mm thickness, and repair is rare because it is easy to apply and defects are not expected application.
- Weather condition tests are not required. During the application, there is no need to test for relative humidity, dew point and ambient temperature. Just make sure that the surface is clean and dry.