3/2022

Pipeline Technology Journal

Ask the Experts

Construction & Coating

WWW.PIPELINE-JOURNAL.NET

e-ISSN 2196-4300 / p-ISSN 2751-1189

Editorial Board

www.pipeline-journal.net
ptj@eitep.de

PUBLISHER
Euro Institute for Information
and Technology Transfer GmbH
Marie-Jahn-Straße 20
30177 Hannover, Germany
Tel: +49 511 90992-10
URL: www.eitep.de

ISSN
e-ISSN: 2196-4300
p-ISSN: 2751-1189

USED COPYRIGHT MATERIAL
P. 1 © Marketing Department, MAX STREICHER GmbH & Co.KG aA

MANAGING DIRECTORS
Dennis Fandrich & Marian Ritter

Register Court: Amtsgericht Hannover
Company Registration Number: HRB 56648
Value Added Tax Identification Number
DE 182833034

EDITOR IN CHIEF
Dennis Fandrich
E-Mail: d.fandrich@eitep.de
Tel: +49 511 90992-22

EDITORIAL BOARD
ptj Editorial Board

TERMS OF PUBLICATION
Four times a year

EDITORIAL MANAGEMENT
Marian Ritter
E-Mail: m.ritter@eitep.de
Tel: +49 511 90992-15
Constantin Schreiber
E-Mail: c.schreiber@eitep.de
Tel: +49 511 90992-20

ADVERTISING
Rana Alnasir-Boulos
E-Mail: r.alnasir-boulos@eitep.de
Tel: +49 511 90992-19

EDITORIAL STAFF
Mark Iden
Daniel Onyango

Ask the Experts

Construction & Coating

Q1) What is the key to success for coating joints in the field ?

Answer: If weld seams or joints are to be safely protected in the field, the processing of the coating material is often subject to very difficult environmental conditions. Whether the influence is temperature, humidity, wind - or even construction site conditions: they can all have a significant impact on the processing and the result, and thus the quality of the coating.

As the international standard ISO 21809-3 defines 11 different families of coating systems, which are themselves subdivided into many sub-categories, the choice of the right coating is very wide and makes the selection of the most successful coating material a challenging task. This task becomes even more difficult when one considers that ISO 21809-3 distinguishes the different products according to their material composition and not according to load classes or resistance in the field.

As the coating of the joints is applied in the field where application conditions are difficult to control and often unpredictable, coating materials requesting the least restrictive application procedure are generally the ones who succeed in the long term.

However, limiting yourself to the conditions during the application of the products would not meet the requirements of the very long service life of pipelines. These can vary greatly depending on soil conditions, chemical, mechanical and temperature loads.

Therefore, the key to success in selecting the right coating for the joints is to use a product that is very easy to process, involves only as few steps as possible, can be corrected during application and withstands the real stresses in the field with the most appropriate corrosion prevention performance.

Q2) What kind of technologies are available to check the quality of buried pipeline coatings?

Answer: First of all, one must distinguish between the quality control of the applied coating in the field when having free access to the coating, e.g. prior backfilling the pipe trench or after excavation of the pipe, and the check during the operation of the pipe in the buried condition.

When checking the quality of the coating onsite having free access to the coating, e.g. in the trench, there a lot of non-destructive as well as destructive methods available, that are listed in the respective standards of the different coatings, e.g. mill coatings or field applied coatings. The most important methods in the field are the following

Non-destructive tests:
- Visual inspection
- Thickness measurement
- Electrical holiday detection
- Electrolytic holiday detection

Destructive test:
- Coating adhesion test
- Peel strength testing
- Shore-D measurement for material hardness
- Chemical analysis

According to our knowledge, a direct check of the quality of the coating in the buried condition is not possible up to now. However, there are methods available to get an indirect impression of the quality of the existing coating, i.e. either detecting a reduction of the pipe wall thickness or detecting coating defects.

These methods include internal inspection techniques such as in line inspection tools, or above-ground non-intrusive techniques such as direct current voltage gradient surveys (DCVG), alternating current voltage surveys (ACVG) and close-interval potential surveys.

partial pressure. This can be a complicated asset specific analysis, but we are finding that some systems may be compatible nearly as-is, with minimal modifications, while some may require modification or upgrading of certain components, whereas other systems may not be feasibly converted without significant upgrades and costs associated.

Q3) How do pipeline coatings interfere with cathodic protection systems ?

Answer: A functioning and coordinated active and passive corrosion protection are decisive for the lasting integrity and failure-free functionality of a newly installed steel pipeline as well as for the achievement of its intended and planned service life.

Passive corrosion protection includes all measures which achieve a shielding/protective effect against corrosive media. This can be attained e.g. by an appropriate selection of anti-corrosion coating as well as design features. The function of a coating is to separate the metal surface to be protected from the surrounding corrosive medium (electrolyte) with respect of mass as well as charge transfer. Such the formation of corrosion cells is inhibited.

In the case of cathodically protected pipelines any coating is the First Line of Defence.

Cathodic Protection (CP) will act as a Second Line of Defence in the event a defect occurs in the corrosion prevention coating.

For technical and economic reasons pipelines are usually protected by a combination of active and passive corrosions protection. This combination has proved its value for many decades.

It is generally accepted that the effect of cathodic protection is based on the activation polarization and the concentration polarization of the steel surface resulting in an increase of the pH at the interface between steel and soil. This increase in pH-value may affect the adhesion of the corrosion prevention coating in the immediate vicinity of the defect. The criterion of cathodic disbondment (CD) is therefore part of all serious standards for the corrosion protection material of steel pipelines laid in soil and water in conjunction with CP.

Interestingly, the effects of the alkaline environment on layered corrosion protection materials - e.g. polymeric tapes or shrinkable sleeves- have not been the subject of normative considerations yet, although possible damage to the coating material by alkali – here layer to layer adhesion - may pose a significant risk to the pipeline. The same applies for the often-neglected parameter of the shape stability. As long as the delaminated coating rests tightly on the steel surface in the form of a tube (shape stability), no corrosion problems occur.

Corrosion can only occur under delaminated coating if a relevant volume is able to push in between the coating and the pipe surface. In other words, if the coating is not dimensional stable or has lost the shape stability, a relevant volume is able to push in between the coating and the pipe surface. As a result, galvanic elements are formed in combination with heterogenic aeration (oxygen concentration gradients) resulting in an enhanced local corrosive attack, e.g. crevice corrosion, despite of the low oxygen permeation through the coating. In the case of a very low shape stability one even could expect, that a very large and continuous volume between the coating and the pipe surface is formed- in a worst case leading to a flow of oxygen containing water between the coating and the pipe surface.

If the coating parameters layer to layer adhesion and shape stability degrade due to a high pH, i.e. pH > 10, the coating loses its functionality. This is independent of the origin of the high pH, e.g. effect of cathodic protection or the use of fluidized soil.

Q4) Do you believe that organic coatings (epoxy etc.) applied inside the pipe would prevent or slow the hydrogen ingress into the steel pipeline ?

Answer: The diffusion processes of hydrogen differ elementarily for organic coatings and for steel. Therefore, the comparison of the diffusion coefficients of hydrogen for these materials is not sufficient to enable a reliable answer to the question.

In the case of organic coatings hydrogen diffuses molecular through the porous material, whereas in the case of steel individual hydrogen atoms diffuse through the metal lattice. This implies in a pre-step the dissociative adsorption of hydrogen leading to adsorbed hydrogen atoms. For this adsorption process free iron atoms are needed at the surface.

On the one hand these iron atoms at the surface can be partially covered by the epoxy coating, whereas in the absence of an epoxy coating iron oxide layers are formed and therefore the number of free, reactive iron atoms is also limited. To what extent an epoxy coating influences the rate of adsorbed hydrogen atoms is still the subject of current research and not clarified.

Finally, we have to state, that due to the described mechanisms a simple comparison of the diffusion coefficients of hydrogen for the different materials is not helpful, in fact it may be misleading.

Q5) Why are there 2-ply and a 3-ply plastic tapes and what is their difference?

Answer: Corrosion prevention tapes and tape systems, made of a combination of i.e. Polyethylene (PE) and Butyl rubber have been on the market for over half a century and have established themselves as the leading quality solution. Out of a wide range of possible combinations, the usual distinctions are between 2-ply and 3-ply tapes.

3-ply tapes are used as corrosion prevention tapes and are wrapped around the pipe as the primary protective layer. Those 3-ply tapes are made of three layers: from the top to the bottom: "compound" – "carrier film" – "compound". The top and bottom layers can be symmetric (same thickness) or asymmetric (very thin layer on the top and thicker layer on the bottom). Due to strong amalgamation of the compounds (butyl rubber) at the overlap area, 3-ply tapes form a homogenous sleeve type coating with no path for water and oxygen and with superior adhesion between tapes layers. A thick compound layer at the bottom for instance ensures best coverage: cavities and picks on the steel surface are protected.

2-ply tapes made of PE/butyl rubber should only be used as additional mechanical protection on top of 3-ply tapes. 2-ply tapes consist of two layers of material: the top laser is called "carrier film" and the bottom layer is called "compound". If the carrier film is made of Polyethylene and the compound is made of butyl rubber, the 2-ply tape wrapped onto a 3-ply tape perfectly bonds to the outer compound of the 3-ply tape. In combination, this tape system provides very good corrosion prevention and mechanical resistance.

2-ply tapes can also be made of Polyvinyl chloride (PVC) as carrier film and bitumen. However, no bitumen is used to manufacture 3-ply tapes.

When using 2-ply tapes as only solution for corrosion prevention, the risk of spiral corrosion occurs as there is no amalgamation between the carrier film and the compound.

Q6) Are there different ways in producing corrosion prevention tapes? Does it have an influence on quality? How can you test the difference?

Answer: Tapes are made of different materials that are interlinked by lamination or coextrusion during the production process.

All lamination technologies have in common that at least one layer has already cooled before it its covered by another layer: a material is applied to a cold, solidified carrier film, which adheres to the carrier material like gluing. The different layers create a bond but are still independent from each other.

In coextrusion technology, different materials are present in molten form during the joining and bonding process. The different melt streams flow into a multi-layer common die through different channels. Along the flow path, the individual melt flows – and therefore the macromolecules of the molten materials – are increasingly combined with each other and mixed to the extent that they penetrate into each other generating at the end of the process one single material line that consists of several layers.

The bond established between the materials is so strong that it can be compared to welding. The carrier and the coating material form one indivisible unit.

As a result, the tape cannot be separated into its individual functional layers, as it might be the case with laminated tapes. Compared with laminated tapes, coextruded tapes show higher layer to layer adhesion and stronger lap shear resistance which ensure outstanding sustainability in the long term.

As a simple test to distinguish between a laminated tape and a coextruded tape we recommend to immerse a piece of tape into petrol for a minimum of 2 hours.

If the residual adhesive is easily removed and the carrier film is smooth or glossy, you can assume a lamination process. If the residual adhesive can only be removed with strong mechanical devices, you can assume a coextrusion process.

Q7) How does pipeline surface preparation and coatings application determine the success of coating?

Answer: This question is related to field-applied coatings where application conditions are more difficult to ensure and verify in comparison to factory applied coatings.

Surface preparation includes cleanliness (from dust, grease, etc.), surface profile (anchor pattern), and moisture (rain, fog or condensation). Cleanliness and moisture affect adhesion, whilst the surface profile affects cathodic disbondment.

Coatings application conditions depend on the coating type:

- Heat shrinkable sleeves need enough heat, including preheat and post-heat, as well as avoiding trapped air under the sleeve.
- Liquid coatings need the correct mixing ratio, proper application thickness, and enough curing between the different passes.
- Tapes need enough tension and constant overlap, both of which are generally easily secured by a manual or motorized wrapping machine.

The vast majority of coating failures that occur on-site are not caused by intrinsic failure of material properties, but by improper surface preparation and/or inappropriate application of the coating. Therefore, the human impact on coating failures must be minimized by developing easy-to-apply and failure tolerant coatings, ideally with only one work step.

A coating system which can be corrected or adjusted during application (also with a machine) is most likely to be the most successful solution.

Q8) What is the recent, innovative advancements being made in the pipeline field applied coatings industry?

Answer: The challenges in the coating industry are constantly increasing with shorter project times, higher standard requirements and still complex application of some products. Besides the permanent protection of pipe sections and weld seams, speed, safety and efficiency are all essential requirements.

A very decisive aspect has been added in recent years: sustainability and environmental protection – also in the corrosion protection solutions used. A clear focus is placed on using as little material as possible and avoiding waste. Likewise, no substances or solvents that are hazardous to health should be used. If, in addition, the work steps for the applicator are reduced and no additional equipment (such as gas flame or UV lamps) must be used, this not only improves the working environment but also the protection of people.

Innovative developments based on high standards fulfillment of ISO 21809-3 and EN 12068, like a tape application without primer and just one wrap to secure corrosion and mechanical protections at the same time, are recently introduced to the market. This represents a milestone in the development of sustainable and safe corrosion protection solutions.

THE EXPERTS

Dr. Thomas Löffler, Head of the Competence Centre Corrosion Prevention, DEKOTEC GmbH
Thomas Löffler holds diploma and Ph.D. in chemistry, specialization in electrochemistry. He has over 17 years' experience in chemical engineering, electrocatalysis and mainly in corrosion protection. He also worked at E.ON Ruhrgas (today OGE) and was responsible for the issues of passive corrosion protection. At DEKOTEC GmbH he is the head of the Competence Centre Corrosion Prevention. He is a member of several national and international working groups of DVGW, DIN, EN and ISO and author of various scientific publications.

Luc Perrad, International Sales Director, DEKOTEC GmbH
Luc Perrad has a master's degree in civil engineering – specialization in Electronics & Mechanics. He has over 14 years' experience in sales and marketing of field applied pipeline coatings in Western Europe, Africa and the Middle East. His functional experience includes marketing, strategy appraisal, due diligence and business management in sales of cold applied polymeric tapes, liquid epoxy coatings, heat shrinkable sleeves, visco-elastic tapes and mesh backed tapes. He joined DEKOTEC GmbH in 2019 and took over the position of International Sales Director in March 2021. Luc Perrad is NACE Coating Inspector Level 2 since February 2014.

With each issue of the journal, the "Ask the Experts" section focuses on a new topic of particular relevance to the pipeline industry. People from the international pipeline community are invited to send in their questions which will afterwards be answered publicly by selected experts from the respective field.

This issue's partner

DEKOTEC

18TH PIPELINE TECHNOLOGY CONFERENCE

8–11 MAY 2023, BERLIN

AN EVENT BY

EITEP

Euro Institute for Information and Technology Transfer

#ptcBerlin

Connect • Share • Expand

Meet the International pipeline community

www.pipeline-conference.com

DIAMOND SPONSOR	PLATINUM SPONSORS	GOLDEN SPONSORS	SILVER SPONSORS
ROSEN empowered by technology	Baker Hughes intero	DEKOTEC NDT Global	TRAPIL GOTTSBERG LEAK DETECTION