New Pipeline Coating Systems - Putting an End to Coating Degradation

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Summary

STOPAQ Pipeline Coating Systems Have Viscous and Self-Healing Properties – A New and Innovative Technology for Rehabilitation and New Construction

Pipelines in oil and gas industries, represent a huge investment and have to operate safe, trouble-free and non-stop for their entire design life. Coating systems should protect the pipeline for external corrosion. However, coating degradation may lead to the creation of serious corrosion risks.

A new innovative low costs coating technology is invented, developed, produced and marketed nowadays by STOPAQ B.V., The Netherlands for rehabilitation and new construction of pipeline coatings and field joint coatings. The chemical and physical properties of the new coating material do not cause the degradation problems encountered when using conventional coating systems.

The new coating material is based on fully amorphous, not cross-linked polyolefins as in a molten polymer. The new coating material exhibits properties that meet the properties of conventional coating systems. On top of that the new coating material has some new additional “live saving and extending” properties inherent to the type of coating material, like self-healing (or rehabilitation) of small damages due to its viscous nature and no problems with so called cathodic disbondment.
Several obstacles have limited the wide acceptance of this technology in the past. The obstacles included lack of good norms and the perception the new material is "an ordinary tape". A technical assessment by Shell Global Solutions was a milestone in a long way which resulted in the description of the new and viscous coating material as field joint coating in an Amendment to ISO 21809-3 which was published in 2011.

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1. Introduction
Corrosion will affect the safe and efficient running of the pipeline and may lead to costs for shut-down, lost production, product loss, and damage to the environment. Coating systems should protect the pipeline for corrosion. However, coating degradation may lead to the creation of serious corrosion risks. Coating degradation problems fall into one of three main causes:

- an inappropriate specification for the coating material or coating process
- poor surface preparation or coating application
- interaction with environment: mechanical, temperatures and electrical currents.

Poor surface preparation and coating application for example may result in loss of adhesion and finally delamination of the coating from the substrate.

The invention and development by STOPAQ B.V. in the Netherlands of a viscous, surface tolerant and self-healing coating system has solved coating problems and application issues encountered when using conventional coating systems in the field.

2. Trends
The demand for failure proof coating systems is high and resistance from competing products is being eroded by a growing acceptance by end-users. It is common knowledge that no traditional anti-corrosion system is completely meeting the needs of the end-user. Traditional products are specified because they are deemed to be the 'best that are available'. What's more, the use of many traditional coating systems is being maintained due to a failure of the end users to properly research and investigate the newer technologies available.
3. New Patented Technology
The new coating technology is a low cost innovation for rehabilitation and new construction e.g. field joint coatings. The new coating technology has been designed and tested to fit field application requirements of oil and gas pipelines. The coating material exhibits properties that are contrary to conventional coating materials and also brings additional properties. The coating material is fully amorphous and is not cross-linked as in a molten polymer. The coating material is inert which means it does not react and degrade easily. The total coating system (coating material + mechanical protection) can be tailored to meet the specific impact, shear and temperature requirements of the end-user. The technology is competitive and worldwide available. It provides the pipeline owner a trusted and proven system which does not need any “looking back”

4. Market Acceptance
The new coating technology has been utilised in pipeline rehabilitation and field joint projects worldwide and is widely specified by many major oil and gas companies. As usual with new technologies it takes time to be adopted. Several obstacles have limited the wide acceptance of this technology so far. The obstacles include lack of good norms, lack of data for comparison of the costs involved for the new coating system compared to traditional coating systems.

5. Technical Assessment
Several coating specifications have been published for field joint coatings such as heat shrink sleeves and tapes but they do not cover the specific material and corrosion protective properties of the viscous coating system. Therefore a technical assessment was performed by Shell Global Solutions according to a product specific specification prepared by Polyvation B.V. The Netherlands. The technical assessment was also used to justify the suitability of the specification.

The extensive test program performed during the technical assessment was used to set the limits of the new coating system for application and operational purposes. The technical assessment by Shell Global Solutions was a milestone in a long way which resulted in the description of the new and viscous coating material as field joint coating in an Amendment to ISO 21809-3 which is published in 2011.

6. Benefits
The facts are that the newer viscous coating materials can provide end-users with anti-corrosion coatings for pipeline rehab systems with much stronger physical properties providing the end-user with less maintenance and reduced costs over time, reduced instance of damage during service due to self-healing properties,
highest levels of corrosion resistance, faster and easier application and installation without need for special equipment and operator skills, better field joining methods and above all lower surface preparation and application costs.

7. Traditional Coating Systems
The data show that traditional coating systems commonly utilized are not performing over the design life of the system exhibiting consistently high failure rates resulting in either major repair works or replacement of expensive distribution systems.

8. Qualification by Shell Global Solutions
The new coating system with PVC outer wrap, described in the Shell report [1], and applied as field joint coating and rehabilitation coating on carbon steel pipes with Fusion Bonded Epoxy (FBE), Polyethylene (PE) and Polypropylene (PP) line pipe coating is approved to be used to a maximum operating temperature of 60 °C for buried and immersion services. The corrosion prevention layer called STOPAQ Wrappingband CZH, however, is approved to be used to a maximum operating temperature of 70 ·C. The upper limit for the PVC outer wrap is set to 60 C for buried and water immersed conditions (Shell DEP 30.10.02.12-Gen, April 2003) and this dictates the maximum operating temperature of the full coating system. The coating system is suitable for application in cold areas with environmental temperatures down to MINUS 45 degrees Celsius due to its viscous behaviour.

9. Self-Healing of coating defects
The new viscous polymer based coating technology exhibits physical properties that meet the properties of conventional coating systems. On top of that the new coating material has some new additional “live saving” properties inherent to the coating material like self-healing (or rehabilitation) of small damages due to its viscous nature (figure 1.) and no so called cathodic disbondment.

Figure 1. STOPAQ self-healing coating technology. Test carried out on coating. Self-healing of a 6 mm diameter artificial defect in less than 24 hr.
The self-healing properties result in additional resistance against possible damaging effects of impact and indentation. The self-healing performance is depending on the temperature, defect size and pressure applied by e.g. the outer-wrap tape or sleeve.

10. No disbondment of coating when peeled.
A cohesive failure of the STOPAQ Wrappingband CZH is observed in the field as a “fail safe”. The substrate stays fully covered with protective coating material. Peel testing on the weld area indicated also a remaining protective layer. No disbondment of the coating will be observed at any cleaned pipeline surface due to the fact that the adhesive forces to the steel substrate are always much stronger than the cohesive forces within the coating material.

Figure 2. Cohesive failure observed during a peel test with a knife in the field. The steel stays fully covered with protective coating material.

11. No Cathodic Disbondment when Cathodic Protection is applied.
The self-healing and recovering property of the new coating system is a strong property. The artificial coating defect made during the cathodic disbondment test is recovered with protective coating material within a day, reducing the current
requirement to zero. No signs of cathodic disbondment are observed underneath the protective coating layer at the location of the defect.

**Figure 3.** Resistance to cathodic disbondment, when cathodic protected. Test showing self-healing (no holidays) of 6 mm artificial defect. Left: experimental set-up. Right: enlargement showing self-healing.

12. **Accelerated Ageing of Coating Material**
In order to determine the effect of aging on the viscous coating material, several coating properties were measured after aging under dry conditions (100 days in air at 90 °C) and aging under wet conditions (100 days in tap water at 90 °C). The wet and dry aging procedures had no negative effect on the coating properties measured.

13. **Application in the field - Comparison to Conventional Systems**
The application of the new coating system is done manually but can also be done by machine and is generally applied without any additional heat requirements. Because the materials used are stable and inert, the application is less susceptible to environmental conditions such as humidity and temperature, compared to liquid coatings or materials which needs curing and drying,
To achieve a reproducible coating the coating application has to be done following the application instructions. Wire brushed steel surface (St 3) is sufficient. The compatibility with the existing line pipe coatings (PE, PP, FBE) is good. According to the STOPAQ application guidelines, no pre-treatment of the line pipe coating is required, except cleaning with an cleaning pad and an appropriate solvent (iso-propanol).

14. Field Experience
A field test was done in the Middle East (where the water table is high) comparing liquid epoxy coating system and the new viscous coating system. Despite the fact that coating material costs are higher than liquid epoxy coating system, it was found that when surface preparation, curing time before backfill, the time used in running the water drainage system, equipment, water rinsing, manpower, holiday test & repair, weather condition, and blasting are taken into consideration, the new coating system is significantly cheaper for a 15 linear meters 60” diameter spirally welded buried pipe. This is equivalent to a savings of about 30%.

Figure 4. Field application of STOPAQ Wrappingband CZH as line pipe coating.

15. References
1. Technical assessment of STOPAQ CZH coating system as field joint coating and as rehabilitation coating. Application on carbon steel line pipe with FBE, PE or PP line pipe coating, Shell Global Solutions, GS.07.50454 by J.R. van Bokhorst.
2. Evaluation of Stopaq pipeline coating, Shell Global Solutions, OP.01.20659 by Gerard van der Schot.
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