

# Cost-effectiveness of Viscous-Elastic Coating for Transportation Pipelines

## Putting an End to Coating Disbondment

*STOPAQ Pipeline Coating Systems Have Both Elastic and Viscous Properties – A New and Innovative Technology for Rehabilitation and New Construction*

Pipelines whether in the oil and gas, petrochemical, water or other industries, represent a huge investment and are required to operate continuously and safely for their entire design life. Anything that detracts from this goal is totally undesirable and every endeavour must be made to prevent all occurrences that might jeopardise the safe and efficient running of the pipeline operation. Corrosion is one of those occurrences that will affect the safe and efficient running of the pipeline with the costs for shut down, lost production, product loss, environment contamination and loss of customer confidence running into millions of euros.

Coating degradation problems that lead to the creation of a corrosion risk within the design life of a pipeline can mainly be attributed to one of the following causes:

- an inappropriate specification for the coating material and/or coating process
- poor surface preparation and/or application
- interaction with the operating environment like humidity, salts, winds, temperatures

Poor surface preparation and coating application continues to create problems with premature degradation, particularly loss of adhesion resulting in disbondment.

### Low Mobilization Cost Approach

The viscous-elastic coating system is an extremely low cost innovative approach for rehabilitation and coating of fieldjoints. This superior anti-corrosion system based on visco-elastic technology has been devel-

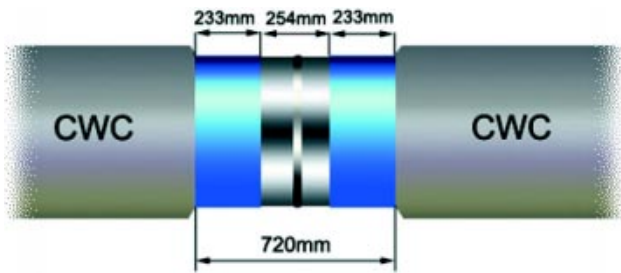
oped for use as the external coating of pipelines. This technology has been designed and tested specifically to fit the special field application requirements of buried oil and gas pipelines, and it exhibits properties that are contrary to traditionally specified systems and in most cases far exceeding them. The visco-elastic products characteristic are fully amorphous and inert and can be tailored to meet the specific soil and temperature requirements of the end-user.

### Market Acceptance

The viscous elastic coating has been utilised in pipeline rehab and fieldjoint projects worldwide and is widely specified by many major oil and gas companies. It is not an unusual situation with new technologies that it takes time to be adopted. As a period of time from development to acceptance is a standard obstacle typical to most industries. Several obstacles have limited the wide acceptance of this technology so far. These obstacles included lack of norms enabling to compare the visco-elastic coatings, cost effectiveness of the systems compared to traditional coatings and resistance to the new technology by companies promoting traditional coatings.

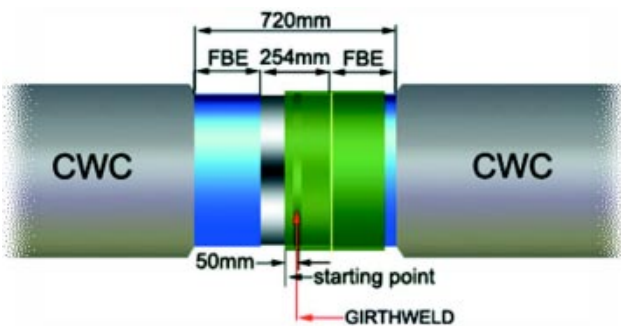
### Extensive Test Program

Several international 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 vis-



Dimensions  
 distance between the concrete weight coating: 720mm  
 .....cutback area: 254mm

CWC = Concrete Weight Coating  
 FBE = Fusion Bonded Epoxy  
 Cutback area = size of exposed steel eachside of the weldseam



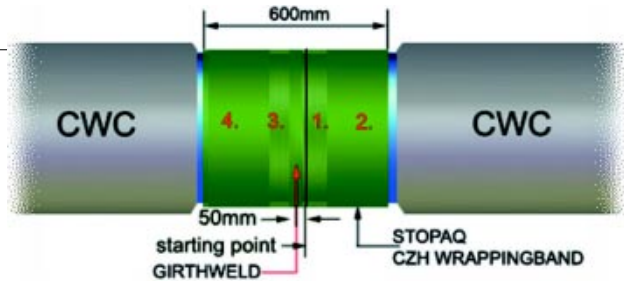
Application  
 1 layer of Wrappingband CZH 200x 20 by application of 4 straight wraps with 50mm overlap starting from the girthweld creating 50mm overlap at the girthweld, the second wrap with an 50mm overlap on the first.

couso-elastic coating system. Therefore the technical assessment was performed according to a product specific specification prepared by Polymer Service Centre Groningen (PSCG), The Netherlands, entitled "Qualification of STOPAQ CZH by Shell Global Solutions", Test document TD-STOPAQ062123 Version 6,

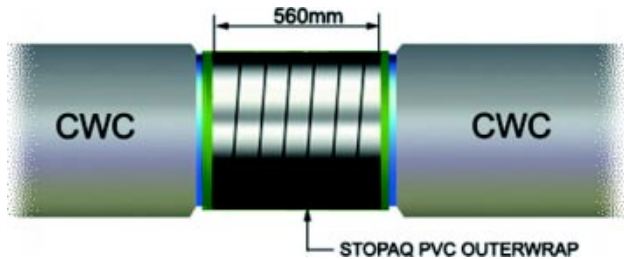
January 26, 2006. The extensive test program performed during the technical assessment was used to set the limits of the viscous-elastic coating system for application and operational purposes and it will also be used to justify the suitability of the specification.

### Trends

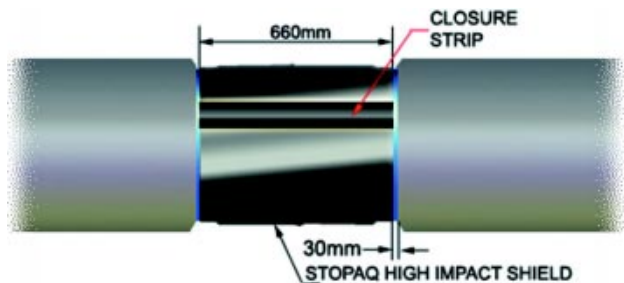
The principal obstacles have been overcome. Visco-elastic coatings will be added to the new ISO norm to be published in 2008: ISO 21809 for field joint coatings. The cost is currently extremely attractive to end-users when compared to traditional coating systems. Due to the trend of outsourcing technical control and inspection by major companies and the lately field repair costs, demand for failure proof systems is high. And resistance from competing products is being



The third wrap must started with 50mm overlap on the other site of the girthweld. The fourth wrap must be applied with an overlap of 50mm on the third wrap.



Application  
 Apply two layers of PVC outerwrap with 50% overlap.



High Impact Shield:  
 free area between the concrete and the H.I.S. = 30mm.

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 products is being maintained due to a failure of the end-users to properly research and investigate the newer technologies available.

### Success of a Coating is no Longer Dependent on Surface Preparation

The facts are that the newer visco elastic coating technologies can provide end-users with anti-corrosion coatings for pipeline rehab systems with: much stronger physical properties providing the end-user with longer investment, less maintenance and reduced costs over time, reduced instance of damage during service due to self-healing properties, highest levels of corrosion resistance, higher levels of chemical resistance, higher process temperature ranges, faster and easier application and installation without need for

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special equipment and operator skills, better field joining methods and above all lower surface preparation and application costs.

### **Operational Excellence**

Anti-corrosion coating failures are a significant factor in reduced operational life of pipelines. The failure of a pipelines coating system accelerates corrosion and can result in leaks requiring repair, cleanup and in some cases replacement of the pipeline. The costs of repair and replacement are significant, as are costs associated with spill containment and cleanups. The cost, environmental impact and negative publicity associated with failures are something every major oil and gas company seeks to avoid. The overwhelming evidence of this data clearly shows 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.

### **Self-Healing Patented Coating Technology**

This new visco-elastic polymer technology exhibits physical properties that meet, and in most cases exceed, the properties of traditional coating systems like tapes, liquid coatings and other corrosion prevention systems. This is especially true in regards to limiting damage during service. This innovative patented technology is competitive and is worldwide available. It provides the pipeline owner a trusted and proven system which does not need any "looking back".

### **Laboratory Testing by a Major Oil Company**

The viscous elastic coating system with PVC outer wrap, described in the Shell report, 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 viscous-elastic coating system is suitable for application in cold areas with environmental temperatures down to MINUS 45

degrees Celsius due to its visco elastic behaviour. The wet and dry ageing procedures had no negative effect on the coating properties. This indicates that the long-term performance of the material is sufficient.

### **Fieldjoint Coating Performance Check**

An extensive test program was executed to obtain sufficient information on the performance of the viscous-elastic coating system to be able to assess the functionality of this new type of coating system for its specified purpose.

In order to determine the effect of ageing on the viscous-elastic material, several coating properties were measured after ageing under dry conditions (100 days in air at 90 °C) and ageing under wet conditions (100 days in tap water at 90 °C).

### **100 days Hot Water Soak Test**

Several international 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 this coating system. Also, the Shell specification for shrink sleeves is not suitable to be used for the viscous-elastic coating system. It was required to prepare a product specific specification for the material. After discussions with STOPAQ Europe and Shell Global Solutions, Polymer Service Centre Groningen (PSCG) compiled a new set of requirements for this special material based on the self healing, visco-elastic and corrosion protective properties of the material and based on existing international standards for conventional field joint coating systems like tapes and shrink sleeves.

The set of requirements for the qualification of the STOPAQ CZH coating system is included in the specification. The outcome of this test program will also be used to justify the suitability of the specification. When the test results indicate that the test criteria are not indicative enough (positive or negative), it may be required to revise the specification.

To determine the effect of ageing on the coating properties of this coating system, test samples were immersed in water at 90°C (wet ageing) for 100 days. Dry ageing of the viscous-elastic coating was performed by exposure of test samples in air at 90°C for 100 days. The temperature of 90°C was selected because the maximum temperature of the coating was set by STOPAQ Europe to 70°C and an additional 20°C is normally used to simulate a long-term effect on the coating material.

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## Comparison to Traditional Protection Systems

The application of the viscous-elastic coating is done manually and generally without any additional heat requirements. For field application, this gives advantages compared to coating systems which require heat treatments. Because the materials used are stable and inert, the application is less susceptible to environmental conditions such as humidity, temperature, etc. compared to liquid coatings or materials which needs curing, drying, etc.

However, to achieve a reproducible coating product, the application shall be done following the application instructions:

According to the producer, wire brushed steel surface (St 3) is sufficient before application. The compatibility with the existing line pipe coatings is good. According to the STOPAQ application guidelines, no pre-treatment of the line pipe coating is required, except cleaning with an appropriate cleaner, but peel testing at -45 °C indicate that the adhesive strength between STOPAQ Wrapping band CZH and existing line pipe coating is highly improved (> 20 N/mm, no detachment) when the line pipe coating is abraded using an appropriate hand or automatic tool.

## No Adhesion Failure

The robustness (i.e. resistance to impact and indentation) of the total coating system is less compared to conventional field joint coating systems, but due to the self healing properties of the viscous-elastic coating, the risk for coating damages is limited. The self-healing and recovering property of the coating system is a strong property of this system. This effect is also shown during the cathodic disbonding test.

The artificial coating defect is recovered with this material, reducing the current requirement to zero and no cathodic disbonding was observed. This property is also stipulated during the peel testing. When a cohesive failure of the STOPAQ Wrappingband CZH is observed, the substrate is fully covered with sufficient coating material, although the peel strength of the coating is limited compared to the peel strength of conventional coating systems.

Peel testing on the weld area indicated a remaining layer thickness of less than 0.6 mm in some cases. This is below the requirement, but in the field an extra layer of the material is applied on the weld area to prevent a reduced coating layer thickness on the weld seam.

Compared to conventional tapes, the measured peel strength is relatively small, due to the nature of this

particular coating material. Actually, a peel test cannot be done on a liquid. All what has been done is peeling out the netting inside the liquid-like polymer compound. No adhesion failure will be found at any pipeline surface.

## No Cathodic Disbondment

The self-healing and recovering properties of the coating system are strong properties of this coating system. The self-healing properties result in additional resistance against possible damaging effects of impact and indentation. Deformations made during impact tests, indentation tests and cathodic disbondment tests can be restored to its initial (undeformed) state. The self-healing performance is depending on the temperature, defect-size and pressure applied by e.g. the outer layer. The self-healing test has proven to be a functional method to quantify the self-healing properties of a visco-elastic self-healing coating system like STOPAQ CZH material. No disbondment of the coating due to cathodic disbondment was observed. The artificial coating defect is recovered with STOPAQ CZH material, reducing the current requirement to zero. The ageing (dry and wet) has no significant negative effect on the adhesion performance of the coating system.

The application of the coating with PVC outerwrap is a relatively simple process due to the nature of this unique material.

## Field Experience

An actual study was done in the Middle East, where the water table is high. Despite the fact that this coating material cost is higher than the compared liquid epoxy coating system, they found out 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, this coating system is significantly cheaper.

In that study, the use of this unique system was estimated to be cheaper than liquid epoxy coating based on a 15 linear meters 60" diameter spirally welded buried pipe. This is equivalent to a savings of about 30%. The factors that made application/installation of this system cheaper are as follows:

- a) Marginal Surface Cleanliness - It requires minimal surface cleanliness (St 2/3 clean and dry) and surface profile is not an issue while liquid epoxy requires near white metal finish (Sa-2-1/2) and a surface profile of at least 75 microns.

- b) No Curing Time - It does not require 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 for one day for each 15 meters long pipe section.
- c) Less Drainage Time - As a result of the elimination of the curing time, the time needed to perform the rehabilitation work will be significantly less, making the cost of water drainage much less in return.
- d) 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 liquid because of the curing time. Stopaq, on the other hand, can be backfilled just after application/installation.
- e) Manual Application/Installation - The application/installation does not require costly equipment. In is installed manually in most cases. For the liquid epoxy coating, equipment such as air compressor, spray equipment, air filter and manifold are used. Furthermore, these equipment and machines need maintenance and spare part replacement, that adds up to the cost.
- f) Less Skilled Manpower - The application/installation also does not require highly skilled manpower. This means less training and lower labour cost. On the other hand, the spray application of liquid epoxy requires skillful manpower to avoid massive premature failures.
- g) Chlorides Removal is not a Requirement - Due to the extremely high surface tolerance of the material, sweet water washing to remove chlorides on the steel surface is not required. On the other hand, liquid epoxy coating requires sweet water washing to remove chlorides on the surface. Additionally, high pressure sweet water washing is required on substrates of pipelines buried in Subkha to ensure removal of chlorides and the  $FeCl_2$  that could form as a result of reaction of  $NaCl$  with the steel pipe.
- h) Holiday Test and Repair are not a Requirement - Holiday test is not normally performed with this particular material, and repair is rare because it is easy to apply and defects are not expected during its application. It is very different with liquid coating that requires holiday and thickness test. Also, holi-

days are expected with liquid coatings; therefore, repair is common.

- i) Weather Condition Tests are not Required - In the application of this coating system, there is no need to test for relative humidity, dew point and ambient temperature. On the other hand, these tests are needed in the application of liquid coatings.

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## Author

*Dr. JF Doddema is Vice President of STOPAQ EUROPE B.V. The STOPAQ Company develops, manufactures and distributes a patented visco-elastic pipeline corrosion prevention and sealing systems globally with a focus on Oil and Gas applications with formulations designed for easy and fast application onto transportation pipelines.*

*This paper was presented at the INDOPIPE 2008 in Jakarta, Indonesia.*

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