

## Service Performance and Life Prediction of Polymer Lined Steel Pipe – “Polymer Lined Pipe and Oil Country Tubular Goods (OCTG)”



**PUBLISHABLE  
SUMMARY**

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### **Background**

There is notable interest in deriving confidence in the use of polymer lined carbon steel pipe for hydrocarbon production applications. The corrosion rate of carbon steel in a polymer lined pipe determines the lifetime of the installation in a sour fluid environment. The requirements for the thermoplastic and composite liners change with service temperature and the nature of the produced fluid that is being conveyed. Failure of the combined system through liner collapse, a phenomenon that is an enduring concern to industry, can be prevented by the implementation of an internally vented system.

In recent meetings at TWI Ltd involving Saudi Aramco and Swagelining, a framework has been agreed in order to facilitate the progression of Joint Industry Project (JIP) Service Performance and Life Prediction of Polymer Lined Steel Pipe and Tubulars - Polymer Lined Pipe & OCTG. This document outlines the current programme of work under Part A of the project, which is concerned with applied testing on lined pipe sections and in addition Part B, which will be run as a TWI Core Research Project. Essentially, Part B will assist with development of a fundamental understanding of both the performance of the polymer layer as a protective barrier and the species developed at the polymer-carbon steel interface. TWI Ltd has the diversity of expertise to deal with all the material components.

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## Objectives

The objective is to determine the degree of corrosion of a carbon steel surface protected by an extruded polymer or built composite liner from a sour ( $H_2S$  containing) fluid environment. Polymer liner material will be chosen from the polyethylene, polyamide and polyvinylidene fluoride family in the first instance. The incorporation of higher temperature polymeric and composite liners to the test matrix will be facilitated as the Sponsorship group grows. The internal venting system studied, in the first instance, will be representative of LinerVent as provided by Swagelining.

## Project Outcome

The aim of Part A of the project is to establish the corrosion rate of a carbon steel tube protected by a well characterised polymer-containing layer during simulated service conditions. Each lined section will have been exposed to a simulated production fluid for a period of 180 days. The occurrence of liner collapse during multiple pressure cycles, in the presence of an internally vented system, will be investigated.

The aim of Part B will be to obtain an understanding of the transport processes through the partially confined polymeric layer. Crucially the development of species in the interfacial region at the carbon steel surface will also be explored.

## Benefits

The current Sponsors of Part A are Saudi Aramco and Swagelining. Part B is funded by TWI Ltd. All Sponsors will achieve a better understanding of the condition of polymer lined pipe after a 180 day exposure period to sour fluid. In the event that other Member Companies of TWI Ltd wish to join the JIP, the programme of work can be expanded to reflect the increased budget available.

## Participants

The external Sponsor Group currently comprises:

- Aramco Overseas B.V.;
- Swagelining Ltd.

## Scope of Work

### JIP Polymer Lined Pipe Part A

A fluid containing a mixture of carbon dioxide, methane, hydrogen sulphide, water, toluene, cyclohexane and heptane, as described in ISO23936-1:2009(E), will be pumped through a polymer lined pipe section for a period of 180 days. Examples of liners under test during the JIP will be from a grade of polyamide, polyvinylidene fluoride and polyethylene. The polymer grades and test conditions will be agreed with the Sponsors. As a guide, the maximum temperature and pressure will be of the order of  $130^{\circ}C$  and 89barg. The liner section will contain internal vents and the lined tube will be subject to depressurisation cycles.

Upon completion of the 180 day conditioning period, the lined pipe system will be dismantled and the assembly examined visually for liner collapse. Subsequently, the pipe will be sectioned to allow both the polymer and polymer-carbon steel interface to be analysed at TWI. Due to the test geometry, a direct comparison can be made between the condition of the carbon steel protected by an extruded polymer layer and the exposed metal surface included in the 180mm end pieces. Importantly, the test geometry provides three post-test inspection opportunities. In short, the 180mm bare sections at the end of the spool provide a control specimen for direct comparison with the condition of both the carbon steel behind the unperforated liner and also that which contains a LinerVent.

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## Scope of Work continued

### Polymer Lined Pipe Part B

The Core Research Activity will aim to increase the understanding of the processes that occur at the polymer-carbon steel interface in terms of:

- Permeation rate of the individual gases through the polymer in the dry condition, with water present and with the hydrocarbon mix present,
- The formation of corrosion product at the interface between the polymer film and carbon steel,
- The presence of corrosion product in the polymer layer and the presence of polymer leachate in the corrosion product.

The extensive permeation suite at TWI allowing four permeation tests to be run simultaneously will be used for this activity.

## Price and Duration

The JIP commenced in October 2014 and has an expected duration of 30 months. Additional sponsors currently holding, or expecting to hold membership of TWI are invited to join and a contribution of £110,000 is required. TWI is also providing a contribution of £110,000 for the underpinning research activity.

## Further Information

For further information on how a Joint Industry Project (JIP) runs please visit:

<http://www.twi-global.com/services/research-and-consultancy/joint-industry-projects/>

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