NOTE

RESTRICTED

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SUBJECT	ASSESSMENT OF A VENTED EXTERNALLY APPLIED GEOMEMBRANE HOSE AS PERMEATION BARRIER FOR TRENCHED SPOOLABLE FIBRE REINFORCED PLASTIC PIPE IN HYDROCARBON SERVICE. 1000 HOUR PRESSURE TEST AT 65 °C

Introduction

The use of Re-inforced Thermoplastic Pipe (RTP) is considered by SPDC to replace crude oil flowlines with a typical diameter of 3”-6”. A feasibility study[1] indicated that the buried application of reinforced thermoplastic pipe for hydrocarbon service is a HSE concern. DEP 01.00.01.30-Gen defines that the use of buried pipe systems where the emission of hydrocarbons and/or toxic fluids is a HSE concern, e.g. pollution of soil and (ground) water, measures shall be taken to prevent emissions occurring.
A vented, externally applied geomembrane hose with controlled release is considered a suitable measure assuming certain requirements are met.

Uche-Chyke Holdings Ltd proposed for a RTP installation demonstration project of SPDC a permeation barrier system consisting of a commercial gas barrier (foil), welding equipment and an end fitting design with venting capability. The geomembrane hose will be produced in situ by welding the foil using a hot air welding machine. For further details on the barrier system see report GS.08.52776.

As part of the assessment of the permeation barrier system GSEI/2 performed two 1000-hour pressure tests at 65 °C. The outcome of these test are reported in this note.

1 GSEI/0068/07 The feasibility of using trenched Polyethylene based re-inforced thermoplastic pipes for crude oil flowlines by SPDC in Nigeria

Experimental

The vendor of the system provided two pieces of a 1.5 m long section of 5” Reinforced Thermoplastic Pipe[2] (RTP) equipped with the barrier and two end fittings with venting capability representative for the envisaged field application. The end fittings with venting capability and installation technique were part of the test.

The installation procedure of the barrier and end fittings was as follows. The permeation barrier was placed externally around the pipe. The barrier foil was welded axially with a special welding machine creating an air channel between two welds. After field installation this air channel will be used for testing the integrity of the welds, according to ASTM D 5820 “Pressurized Air Channel Evaluation of Dual Seamed Geomembranes”. At the outer ends, the barrier was adhered to the pipe using a polyurethane resin between pipe and barrier. The surface of the pipe was cleaned prior to application of the resin using a solvent.

Steel clamps were placed around the barrier at the polyurethane resin position. Rubber slabs were placed between the steel clamps and the barrier foil to prevent damage of the barrier foil from sharp edges of the clamp. Next to the clamps a Polyvinylchloride (PVC) based venting system was placed according supplier (Pipelife) procedures (Photos 1, 2 and 3).

The PVC venting system was used in the test to pressurise the barrier. One end was connected to compressed air whilst the other end was slowly vented using a backpressure device to maintain a constant pressure level.

In order to prevent excessive ballooning of the barrier a PCV pipe was used to minimize the expansion of the barrier during pressurisation (Photo 4). This was considered representative for a buried pipe system.

After mounting, the specimens were leak tested at 20 °C and 0.6 bar overpressure using compressed air. One of the specimens showed leakage between the barrier and pipe and was therefore not further tested. The remaining specimen was placed in a hot air container. Temperature was set to 65 °C, the pressure to 0.45 bar overpressure. The specimen was inspected for air leakage on a daily bases using the pressure level as parameter.

Results

Specimen 1
This specimen showed some leakage underneath the steel clamp on one of the end fittings at the start of the test and was therefore not further tested.

Specimen 2:
The specimen started to leak air after 300 hours of 0.45 bar overpressure. Visual inspection showed leakage of air between one of the PVC venting clamps and the barrier foil. The barrier foil itself and its welded areas did not leak.

2 For further details see report GS.08.52776

Discussion

The test results show the need for improvement of the barrier end-fitting design. The selected barrier foil and welding technique appears fit for purpose. Earlier preformed scouting experiments already showed that Uche-Chyke Holdings Ltd had difficulties providing a robust end fitting design for the barrier systems. Despite the fact that the installation was done under ideal conditions, that is indoors in a dedicated workplace, one end fitting already leaked before the 1000 hour test was started. The second specimen failed after 300 hr test due to a leak path underneath one of the PVC venting clamps. Stress relaxation of the PVC, due to elevated temperature in the test, resulting in a loss of tension in the clamps could be the cause of the loss of the sealing capability.

In view of the harsh field conditions in Nigeria i.e. a swamp area at elevated temperature, high level of humidity and difficult working conditions, a more robust end-fitting design is required.

Conclusions

- Both specimens failed, one before the 1000 hour test and one during the 1000 hour test, due to a leak at the permeation barrier end fitting.
- The current permeation barrier end fitting design and application method of the end fitting of the barrier foil is unsuitable for the envisaged application.
- The selected barrier foil and welding technique seem fit for purpose but still need to be qualified in a 1000 hour test.

Recommendation

- A redesign of the end fitting and improvement method of installation is required.

Photo 1   *PVC venting clamps as supplied by the pipe manufacturer*

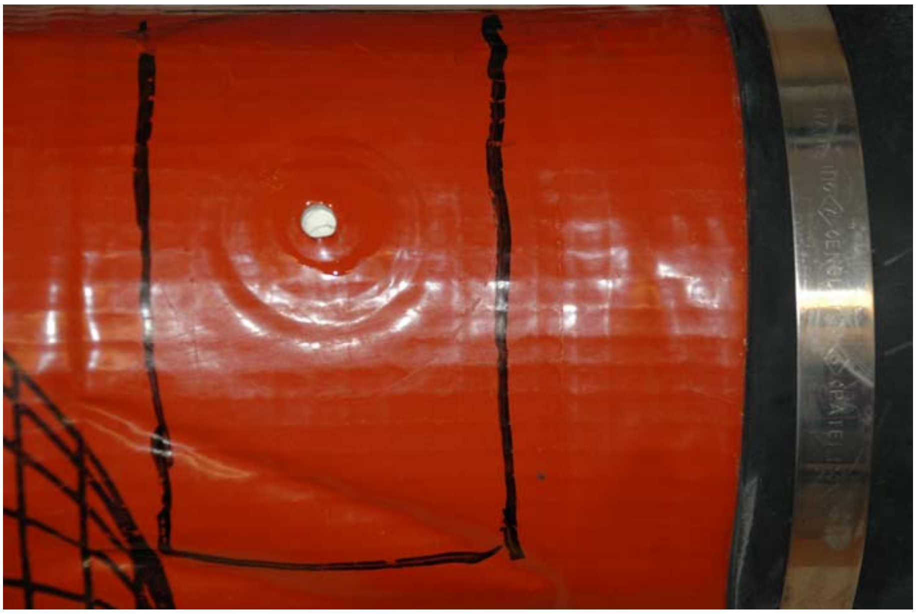

Photo 2 *Vent hole in the barrier system before PVC clamps are placed*

Photo 3 *Venting system and metal clamps in position*

Photo 4 *Test sample including anti ballooning PVC pipe*