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Latest Concepts of Plastic-Lined Flowlines for Deepwater Field Developments

M. Beunier, F.R. Pionetti, K. Ardavanis, E. Gourdoux, B. Mauriès, and K. Lachheb, Saipem

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Abstract

In deepwater, corrosion protection of flowlines is becoming a major issue as fluid (production or injection) aggressiveness, temperature and pressure increase. Conventional corrosion allowance of carbon steel flowlines leads to excessive procurement costs, installation weight and welding thickness resulting in non economic solutions. Clad flowlines present excellent corrosion protection, but the implementation of this technology results in quite expensive solutions with additional NDT difficulties during installation.

An interesting alternative to achieve an acceptable corrosion protection in most conditions is the use of plastic liners. However, plastic lining has been mostly limited up to now to reel lay. Transposing as such this technology to J-lay results in a complex quad joint design inducing more welding and NDT difficulties at every offshore joint. Therefore, the use of this attractive technology in J-lay implies the development of a specific field joint design.

SAIPEM SA has developed and patented an innovative and cost effective field-joint system (the Inconel Field Joint). This system maintains the corrosion barrier across girth weld locations along the flowline. This technology has minimal impact on the offshore laying rate due to performing standard steel to steel welds. It is associated to an integrated lining solution including all piping accessories by rotolining.

This paper presents the main characteristics of the IFJ system for a typical deepwater water injection application and discusses the results of the extensive qualification program carried out over the last two years, including swage lining, machining, sleeve insertion, leak test and welding tests.

Introduction

Corrosion protection is a key issue for both production and water injection pipelines. Several technical solutions have already been developed and used for internal corrosion protection of carbon steel flowlines (see **[1]**).

The most common one, corrosion allowance, consists in an extra steel layer on the inner face of the pipes, usually ranging from 3 to 10 mm. Although this method is rather straightforward from a fabrication standpoint, it also leads to longer offshore welding time, larger steel quantities (and thus higher steel procurement cost) and finally to heavier flowlines. This latter point may become a showstopper as water depth increases.

Entire internal cladding or overlay using corrosion resistant alloys such as Inconel is another solution, well adapted to highly corrosive fluids but time-consuming and expensive as far as pipe fabrication in concerned. Also, offshore welding and weld inspection is much more complex that for carbon steel.

The last group of solutions have the common feature of using internal plastic liners as a means to protect carbon steel from liquid and gases flowing in the line. Plastic lining has already been applied to reel lay or J lay (double or quad joints), for water injection and production (see **[1]**). For reel lay, sections of hundreds meters of liner are inserted in the flowline, which requires a long onshore spool base. For J lay, plastic liner is inserted in the joint assembly (quad joints for instance) using a rather simple method that can be applied on almost any yard, thus opening opportunities for local fabrication.
In both cases, a specific field joint must be inserted in the plastic liner at weld locations to avoid plastic liner damage and still maintaining the corrosion barrier. Several concepts have already been developed and even installed for some of them. However, most of them make use of Inconel for the internal locking ring needed to maintain the field joint in position and for cladding of carbon steel pipe ends. Therefore, such field joints are quite expensive to procure and require specific welding and non destructive testing (NDT) procedures, which limits their use to reel lay, where only a few field joints are needed along the whole flowlines.

Consequently, SAIPEM has developed a cost effective concept of field joint to be used with plastic lined flowlines, the Inconel Field Joint (IFJ), tailored to J-lay installation.