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New Monitoring Technology for Detection of Flexible Armor Wire Failure

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Abstract

Flexible risers have been one of the preferred riser solution for many floating production systems in shallow to deepwater in many regions of the world for their good dynamic behavior and their reliability. The flexible pipe is composed of several plastic and steel layers. The weight of the riser is carried by a large number of steel wires (called tensile armours) that are essential to the integrity of the pipe. It is therefore important to be able to ensure the integrity of those armour wires and to detect a possible failure early enough to intervene in time, inspect the riser and if needed plan to re-terminate or partially replace it.

To answer to this operational and safety issue, Technip and Schlumberger Subsea Surveillance (SSS) have a joint effort to develop a new technology allowing to detect failure or conditions likely to lead to failure of tensile armour wires. This new monitoring technology is based on a clamped composite structure with embedded optical fiber using among others Fiber Optics Bragg Gratings technologies (FBG). The developed device allows capturing armour failure monitoring the permanent deformation (torsion and elongation) results from an unbalanced equilibrium of the tensile armour layers. These crossed informations increase reliability of integrity assurance.

The paper will present the essentials of the behaviour of the armour wires in a flexible riser, and the resulting requirements that need to be taken into account for the development of a system monitoring their possible breakage. The selected technologies and their optimization are presented as well as the way they are integrated in the riser system. The pipe and monitoring equipment prototypes are presented.

Introduction

Continuous integrity surveillance of flexible risers is an emerging technology that aims at maximizing the safe service life against degradation in hostile operating environments. Continuous surveillance measures are designed to detect the earliest signs of degradation of integrity so that mitigating actions can be implemented well in advance for maintaining the safe operation of the riser system.

Some failures of flexible pipe armour wires in particular cases, offshore, over the past years, has caused a growing interest in Integrity Surveillance of tensile armors in flexible risers, Anderson (2007), Marinho (2008). The damage usually occurs in the upper sections of the riser between the wave zone and the topsides hang-off. The external sheath of a flexible riser has a higher risk of damage in this zone, potentially resulting in corrosion or corrosion-fatigue of the tensile armor, which could eventually lead to a failure of tensile armor wires.

A flexible riser is highly redundant against failure in the tensile mode thanks to the a large number of tensile armour wires (no less than 40 and up to 240). Early detection of breakage of some wires due to material degradation could thus prevent failure of the riser. Current integrity practice may not detect a damage location for several months or years due to the infrequency and uncertainties of general visual inspections and riser annulus tests. External access to a flexible riser within a platform conductor tube is very restricted and prevents general inspection for integrity assessment.

Technip and Schlumberger Subsea Surveillance (SSS) are collaborating to develop new technologies for monitoring failure of tensile armor wires. The surveillance systems provides advance warning that allows resources to be allocated for confirmation of damage and implementation of mitigation measures. Both integrated and retrofit surveillance system are being developed. The technology described in this paper is based on a retrofit clamp that monitors axial elongation and torsional twist of a flexible riser. The paper reviews the project background and the progress to-date of the ongoing development.