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Development of a Failure Detection System for Flexible Risers

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ABSTRACT

In the past few years there have been a number of in-service flexible risers which have failed offshore. Due to the significant environmental, safety, and physical cost of a flexible riser failure occurring, an integrity management system is required by the industry to safeguard the risers currently in operation. The majority of the known cases of critical damage to flexible risers concern the armor wires at the top section of the riser. This paper presents the results of the laboratory test conducted with a bank of sensors installed on a flexible riser test piece under tensile load. The test was conducted in order to detect damage to the armor wires using non-invasive sensors and to help understand the process of flexible riser failure. An additional offshore test was conducted in order to validate the proposed system under offshore conditions. This will increase confidence in the ability to predict potential failure and improve riser system integrity. The tests show that it is possible to detect and identify armor wire failures.

KEY WORDS: Flexible Riser; Integrity Management System; Armor Wire Failure; FlexASSURE.

INTRODUCTION

The design of flexible risers is a complex engineering process based on presumptions about environmental loading conditions and the specific requirements of the application over its lifetime. As offshore developments expand into increasingly deeper water depths, frequently the flexible risers are being used at the limit of their design capability. Flexible risers can also have problems unique to their design. The difficulties resulting from flexible riser connection failures and the consequences of fatigue failure in deepwater remote areas, which lack reliable environmental data, have led to the development of a whole new industry of riser integrity management. Such systems include hardware monitoring, data acquisition, and data interpretation needed to monitor the response of the riser and record levels of fatigue damage. This information can then be used to tailor maintenance and intervention plans, and ultimately to predict the possibility of riser failure.

Once a flexible riser has been installed, a number of problems can affect its performance and lifespan. The majority of the reported cases of damage to flexible risers describe damage located in the top section of the riser, close to the bend stiffener (Marinho M.G., Santos J.M., Carneval R.O., 2006). These include external sheath damage, corrosion and/or fatigue induced damage to the tensile armors, and torsional instability associated to tensile armor rupture. Contact between the riser and platform hull or repeated clashing against another riser are common, especially on semi-submersible units, due to the large drift of the platform. In the I-tubes it is common to find damage to the riser in the form of external sheath abrasion and breaching caused by interference with the bend stiffener internal insert. As large diameter flexible risers get close to the threshold of flexible construction technology, the armour wires become more sensitive to fatigue, especially in high stress concentration regions like the interior of end fittings.

Flexible risers play an outstanding role in deepwater offshore operations worldwide. In Brazil, for example, there are some 1,200 flexible risers in service which are responsible for the transportation of around 80% of all oil and gas produced in the country. Outside of Brazil there are more than 1,000 flexible risers in use in the UK section of the North Sea alone.

In order to develop a failure detection system for flexible risers, preliminary tests under controlled conditions are conducted to detect damage to the armor wires using non-invasive sensors attached to the riser. The objective of the test is to understand the process of flexible riser failure, and to determine if it is possible to detect armor wire failure using non-invasive monitoring techniques. The test described in this paper was conducted following an invitation from the Brazilian state oil company Petrobras. Petrobras was interested on developing methods for early flexible riser failure detection and decided to test several technical approaches available in the market. Additional offshore verifications were conduced in order to assure the efficiency of the system under operational conditions.

FLEXIBLE RISER FAILURE MONITORING SYSTEM

As the process of flexible riser wire failure is not well understood, the strategy for the test is to monitor as many parameters as possible in order to extract the maximum amount of information.

A range of sensors are used to pick-up a range of physical properties such as acoustic emission and riser movement. Suitable anti-aliasing filters are used in all sensors. The data logging system captures data continuously and all measured data is saved onto a hard disk for later processing. The measured data is also processed on-line and the values displayed on the PC screen in real-time.