

Flexible pipe integrity management: searching for the Holy Grail

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With the increased use of unbonded flexible pipes in offshore applications, the drive for integrity management (IM) solutions rivaling those available for rigid pipelines is steadily increasing.

This demand is evident both in product improvements for newer flexible pipes and with numerous innovations in monitoring and external scanning solutions for in-service assets.

The current challenge for operators is to develop and implement robust and cost-effective IM strategies to maximise the value of these critical assets. Rosen is now applying its in-house expertise and technical knowledge to develop a range of support services and technical solutions.

THE FLEXIBLE PIPE AND RISER MARKET TODAY

With respect to new projects, the design and installation of flexible pipes has advanced significantly in the past decade. Key influencing factors include evolving industry standards (driven by a better understanding of key failure modes), improvements in materials, and more-advanced design, manufacturing, and testing methods.

In more recent years, progress has been

hastened by the need to accommodate more challenging field applications, including deep water, H₂S service, high CO₂ levels, higher pressures, increased diameters, and extended life.

For more remote locations there is also an increasing need to minimise inspection and maintenance activities. This progress can be illustrated by the significant increase in the number of load cases used to assess and verify fatigue life for a dynamic riser (from under 50 in the early days to up to 5,000 m today).

Globally there is now a large number of flexible risers in operation, with a significant number approaching or exceeding their original stated design life. Additionally, there is a large number of installed subsea flexible jumpers and production tie-backs (static applications), with an increasing trend to select flexibles for such applications.

With respect to in-service and ageing assets, operators face a daily challenge to ensure that they are being operated correctly, failure risk is

minimised, and the desired remnant life is attained. In many cases exceeding the original stated design life is necessary to align with extended field life.

DEVELOPING INTEGRITY SOLUTIONS

In recognition of the demand for integrated IM solutions, flexible pipe manufacturers are developing innovative solutions for online monitoring through integrated sensing systems. Examples include magnetic stress measurement, online vent-gas analysis, distributed temperature sensing (fibre optic), and electrical armour-breach detection systems.

Other third-party innovations include systems to monitor riser position, which are being adopted on several new FPSO developments. While the use of such solutions is not yet commonplace, they infer a future where the care and maintenance options for flexible pipes rival those of rigid pipeline systems.

One of the main barriers in implementing new innovation lies in the way flexible pipe is procured, with project CAPEX budgets tightly controlled. This is often without full consideration given to subsequent OPEX (for example, full product life-cycle cost and management of operational risk).

CURRENT IM PRACTICE

IM practice for existing flexible-pipe systems is steadily evolving, from distinct approaches adopted by individual operators, to methods more akin to those adopted for rigid pipelines. This includes adopting IM systems to capture the key inspection and testing routines to be implemented.

Key elements within a generic 'plan-do-check-act' cycle can typically include:

- » monitoring operating conditions and bore-fluid composition
 - » ROV inspection
 - » visual inspections
 - » annulus testing
 - » vessel motion and weather monitoring.
- Other, less common items include:
- » annulus-gas sampling/monitoring
 - » polymer-coupon ageing checks
 - » external-scanning systems
 - » magnetic stress-measurement tools.

Rosen is working to support operators by developing a dedicated IM approach for flexible

risers. The company's flexible-integrity-management system (FIMS) approach can be implemented either as a second-level procedure, to be integrated into an existing over-arching pipeline-integrity-management system (PIMS), or a top-level system for an individual field development.

The methodology is based on implementing a cost-effective annual integrity-review cycle, ensuring adequate routine monitoring is in place so that the remnant life of the asset can be reliably predicted. This is achieved primarily through contrasting observed operational use with the original design criteria in order to restate estimated remaining life, with more-detailed assessments only conducted when conditions outside predefined limits arise or at fixed-term intervals (such as five years).

THE ROLE OF PIGGING

The role of in-line inspection (ILI) tools in diagnosing the condition of a flexible pipe is often seen as a potential future silver bullet. However, achieving a workable solution represents a significant challenge, considering the complex layered structure of an un-bonded flexible pipe.

Rosen is investigating what can be achieved using existing inspection techniques to better understand the potential of delivering an ILI solution. This is being instigated through re-evaluating inspection data from previous

operations, where ILI tools have transited flexible pipe sections (typically production jumpers), and through testing work at the company's Technology and Research Centre at Lingen in Germany.

While ultimately it may prove challenging to develop an inspection solution that can be deployed for all the major anticipated degradation mechanisms, it is already apparent that adaptations to existing tools and techniques can potentially yield useful integrity data.

WHERE TO FROM HERE?

Flexible-pipe systems to support subsea oil and gas extraction have evolved significantly over recent years, facilitating the use of more cost-effective floating-production systems (FPSOs) and unlocking resources in more remote and challenging locations.

Although flexible pipe is proven to be very durable and can give a long operational life, ensuring integrity throughout its full life-cycle remains challenging.

While coherent strategies and tools to monitor and diagnose the health of flexibles are being developed, there is still no solution to rival that of an ILI for a rigid carbon-steel pipeline.

Rosen is now working to support the industry through providing a range of IM services, and investing R&D effort to investigate potential ILI solutions. ■

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