SPECIAL REPORT

High Performance Subsea Inspection Techniques for Oil and Gas Operations

Next Generation Subsea Inspection Services and Solutions

What Drives Inspection?

Engineering and Infrastructure

An Eye on the Future

Challenges to Inspection Techniques

Sponsored by innospection

Published by Global Business Media

Global Business Media

Published by Global Business Media

Global Business Media Limited
62 The Street Ashtead Surrey KT21 1AT
United Kingdom

Switchboard: +44 (0)1737 850 939
Fax: +44 (0)1737 851 952
Email: info@globalbusinessmedia.org
Website: www.globalbusinessmedia.org

Publisher
Kevin Bell

Editor
John Hancock

Business Development Director
Marie-Anne Brooks

Senior Project Manager
Steve Banks

Advertising Executives
Michael McCarthy
Abigail Coombes

Production Manager
Paul Davies

For further information visit:
www.globalbusinessmedia.org

Contents

Foreword

AT EVERY stage and at every level, offshore, subsea oil and gas exploration and production is hazardous as well as very expensive. Whether it's the efficiency of the drilling equipment or the quality with which structures and equipment are built, a lot depends on how well those early stages are carried out. As importantly during production, the efficiency and reliability of equipment is critically important not only for commercial purposes but also because regulation now sets parameters and standards at every stage in the process. Failure can be costly in terms of lost production and the price of repair, replacement and renewal, but also, if the failure causes damage to the environment, the cost of cleaning up, regulatory fines, compensating any who have been adversely affected and reputational damage, can be immense. Little wonder that most operators would say that prevention of failure is better policy than trying to deal with its consequences. And inspection is a very important element in any prevention strategy.

The opening article in this Special Report looks at Innospection, a specialist provider of advanced and innovative services and solutions, with particular emphasis on the inspection of subsea and splash zone infrastructures such as pipelines, platform legs, caissons and rigid and flexible risers. The article goes on to describe a number of the techniques developed and used by Innospection including the MEC (Magnetic Eddy Current) technique and subsequent further developments. Since 1998, they have been providing Non-Destructive Testing (NDT) services and solutions to worldwide process industries, including the onshore and offshore oil and gas industries, refineries and petrochemical and power plants.

In the second piece we look at the global drivers that are making it necessary to find and exploit oil and gas reserves in ever more difficult places including offshore and subsea. The article also considers how changing attitudes towards the environment are adding a new dimension to operators' worldview. Francis Slade then considers the engineering and infrastructure that make up the offshore oil and gas sector, some of its vulnerabilities and where good inspection can make a difference.

In the following article, Peter Dunwell looks at how a growing market drives a demand for evermore equipment and how other pressures can make it important to optimise the return on what are considerable investments. Finally, we consider some challenges faced both by exploration and production equipment, and by any inspection tools and technology used to monitor it.

John Hancock
Editor

***John Hancock** joined as Editor of Offshore Reports in early 2012. A journalist for 25 years, John has written and edited articles and papers on a range of engineering, support services and technology topics as well as for key events in the sector. Subjects have included aero-engineering, auto-engineering and electronics, high value manufacturing, testing, aviation IT, materials engineering, weapons research, supply chain, logistics and naval engineering.*

Next Generation Subsea Inspection Services and Solutions

***Andreas Boenisch,** Innospection Limited*

The mature and ageing North Sea assets have led the operators to focus increasingly on the integrity management of the offshore installations. The splash zone and subsea components in particular become subjects of increasing inspection demand and extensive condition assessment with the target for lifetime extension and to demonstrate fitness-for-service. As a result, the industry encourages the development of advanced subsea inspection solutions.

Andreas Boenisch, Group Managing Director of Innospection Ltd, a specialist provider of innovative inspection services and solutions, explains how the next generation of high performance subsea inspection techniques and tools developed by Innospection could help Operators to solve longstanding and niche subsea inspection challenges.

Introduction

The requirement for the inspection of splash zone and subsea infrastructures such as rigid and flexible risers, caissons, subsea pipelines and structures such as platform legs has grown in the North Sea and offshore operations in other regions due to the increasing focus on the reliability and safety of the offshore assets. This demand is not only the subject of the Operators' drive to ensure the fitness-for-service of their assets but also to ensure the safe operation, both for their own interest as well as to demonstrate proactiveness to the authorities.

Maintaining the integrity of the offshore oil and gas production assets is a huge challenge, especially for subsea infrastructures due to accessibility issues and inspection conditions. Traditional subsea inspection methods such as General Visual Inspection (GVI) or Close Visual Inspection (CVI) are no longer sufficient to allow a sensible integrity assessment. At the same time, not all advanced Non-Destructive Testing (NDT) technologies proven for the topside and onshore inspection are suitable or easily deployed in the underwater environment.

A specialist in electromagnetic inspection technologies such as Eddy Current and Saturation Low Frequency Eddy Current (SLOFEC) and Magnetic Eddy Current (MEC), Innospection has delivered advanced NDT services and solutions to the worldwide process industries including the on- and offshore oil and gas industry, refineries, petrochemical and power plants since 1998.

With a reputation for expertise in advanced NDT solutions, Innospection is frequently tasked by oil and gas Operators and integrity management suppliers to provide customised solutions and equipment to longstanding inspection challenges. Since 2006, market demands have driven Innospection to develop dedicated inspection solutions to solve niche inspection challenges for subsea infrastructures such as rigid and flexible risers, caissons, subsea pipelines and structures, mooring lines, ship hulls, etc.

High Performance Subsea Inspection Techniques

Amongst the various inspection techniques offered by Innospection, two high performance subsea inspection techniques are explained in this article.

The electromagnetic testing technique "**MEC**" (Magnetic Eddy Current) is the main inspection technique and is applied to most of Innospection's next generation of topside and subsea inspection tools to support integrity assurance.

The **MEC-FIT™** technique is developed by Innospection to provide a reliable and technically advanced solution for the inspection of flexible risers and flexible pipes operated from offshore installations.

MEC – Next Generation of SLOFEC

MEC is the next generation of the fast corrosion mapping technique based on the

With a reputation for expertise in advanced NDT solutions, Innospection is frequently tasked by oil and gas Operators and integrity management suppliers to provide customised solutions and equipment to longstanding inspection challenges

further development of the industry proven Saturation Low Frequency Eddy Current (SLOFEC) technique.

The principle difference is that MEC technique operates on Magnetic Field Controlled High Frequency Eddy Current, as opposed to SLOFEC which operates at a lower frequency. In addition, the MEC technique uses specifically developed Eddy Current sensors which are able to generate a higher density Eddy Current field for increased defect detection sensitivity.

The specifically developed Eddy Current sensors have a built-in hall sensor to enable the measurement and adaptation of the magnetic field strength. By analysing and controlling the magnetic field strength to operate at the retentivity point of the hysteresis curve and combining it with higher operating frequencies, the MEC technique is capable of detecting defects at a higher wall thickness and stand-off (coating) range. With an improved signal to noise ratio, the MEC technique has proven to be capable of inspecting through a 35mm fire protective coating for defects beneath.

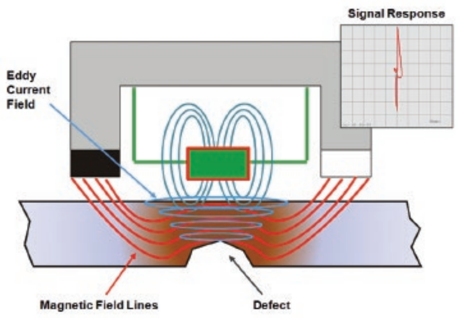


DIAGRAM 2 – DETECTION OF FAR SIDE DEFECT WITH CORRESPONDING SIGNAL RESPONSE

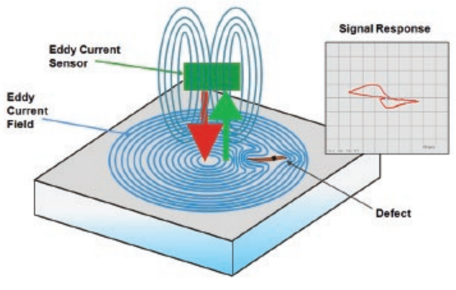


DIAGRAM 3 – DETECTION OF NEAR SIDE DEFECT WITH CORRESPONDING SIGNAL RESPONSE

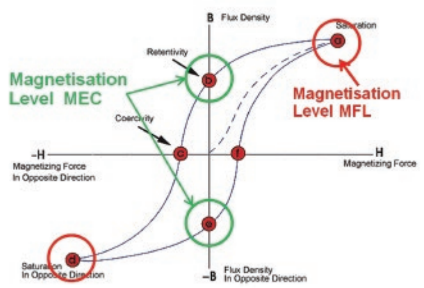


DIAGRAM 1 – CONTROLLED MAGNETIC FIELD STRENGTH OF MEC TECHNIQUE

The MEC technique is a dynamic corrosion mapping technique. By superimposing the direct current magnetisation with an Eddy Current field, the depth of penetration is increased to such an extent that the internal defects such as corrosion, cracks and pitting can be detected from the external surface.

While the defects affect the direct current magnetic field lines inside the remaining wall of the inspection object, a change in the relative permeability consequently affects the Eddy Current field. This is displayed as impedance for each Eddy Current sensor in the sensor array in comparison to the calibration displaying the wall loss in amplitude. The signal phase analysis enables the internal and external defects to be clearly distinguished from each other.

The MEC technique is capable of inspecting ferro- and non-ferromagnetic steel components including through various types of coating such as CRA, TSA and Monel, without the coating removal. Direct surface coupling between the sensor system and the inspection object is not necessary, which enables this technique to be utilised as a non-intrusive inspection method. Cleaning of the inspection surface to the bare metal is also not required for producing good quality inspection data. These serve as major advantages over Ultrasonic capabilities and make the MEC technique uniquely suitable for subsea inspection applications.

MEC-FIT^{TM} – Flexible Riser Inspection Technique

The patented MEC-FIT^{TM} technique has been specifically developed for the external fast screening of flexible risers in-situ with visibility of the multiple wire layers to detect wire disorganisation and defects such as metal loss or wire cracking, but without the risk of damaging the integrity of the flexible riser.

By combining magnetic field lines with Eddy Current field lines, the MEC-FIT^{TM} technique not only allows the deeper penetration into the various armour layers for defect detection in the inner layers, but also enables the optimisation of inspection for a specific layer from which a defect signal is received.

The specifically developed sensors and magnetic system has demonstrated sensitivity in the detection of single or multiple wire cracks and corrosion (pitting areas or individual pits) in the first and second tensile armour layers and, to some extent, damage and interlocking failures in the third pressure armour layer. Being an electromagnetic technique, no annulus flooding is required for the inspection, which minimises damage to the flexible risers.

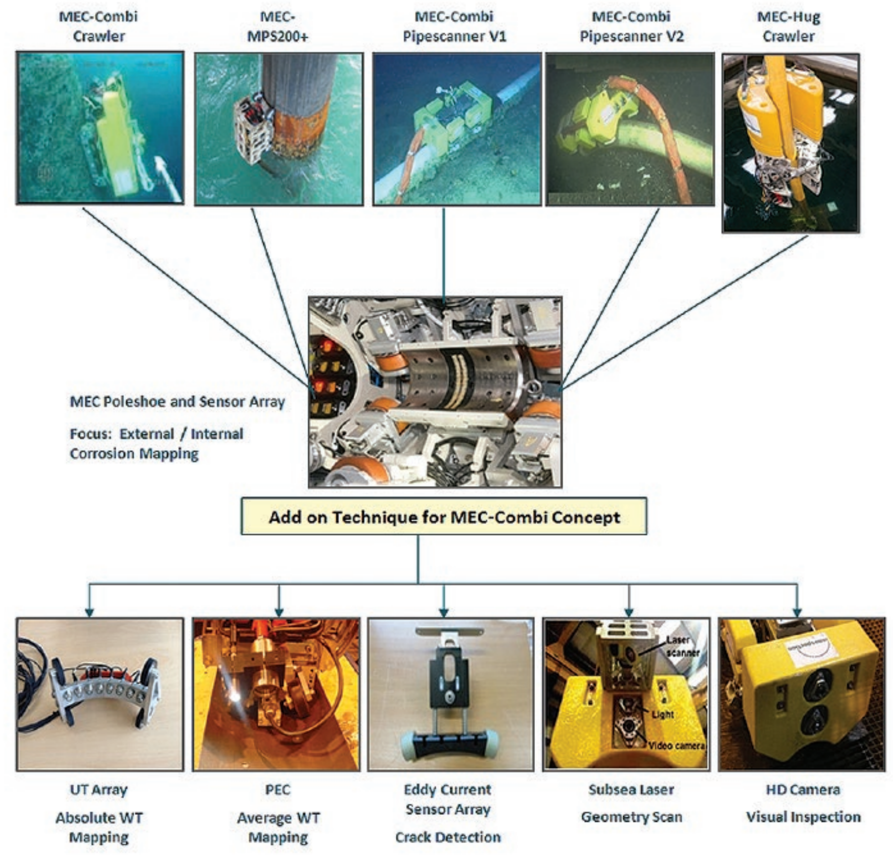


DIAGRAM 4 – NEXT GENERATION MEC-COMBI CRAWLERS & PIPESCANNERS

Originally used for the detection of metal loss and cracking in flexible pipes with armour layers having a 30°-45° wire angle setup, the MEC-FIT^{TM} technique has been further developed and successfully verified to be sensitive also in the detection of defects in flexible pipes having a tighter armour wire setup at 15° angle. With a signal to background ratio of >6dB, a 90% Probability of Detection was achieved for defect types such as single and multiple wire gap in the outer layers, multiple wire gap in the inner layers as well as extra wire on top outer layer at 15° and 35° wire angle.

The MEC-FIT^{TM} technique has been successfully deployed for the inspection of flexible risers and flexible pipes in the North Sea.

Subsea Inspection Applications with MEC-Combi Crawlers & Pipescanners

To deploy the high performance subsea inspection techniques, a range of sophisticated next generation MEC-Combi Crawlers and Pipescanners has been designed and built to provide comprehensive inspection data within a single deployment for the inspection of the following subsea assets:

- Risers, caissons and conductor pipes
- Flexible risers
- Subsea structures and ship hulls
- Subsea pipelines
- Mooring lines

In addition to the MEC technique, the MEC-Combi Crawlers and Pipescanners enable supporting inspection techniques such as high resolution Ultrasonic for absolute wall thickness mapping, Pulsed Eddy Current (PEC) for average wall thickness mapping, laser triangulation system for geometry scan, high definition camera system for visual inspection, Eddy Current crack detection system, Time of Flight Diffraction (TOFD), etc. to be incorporated to provide a total and customised inspection solution.

The MEC-Combi Crawlers and Pipescanners can also be equipped with an advanced integrated cleaning system to enable a simultaneous cleaning and inspection operation. Deployed by ROV or divers from the support vessel or from the installation by rope access personnel, they are designed to be self-driving and enable the fast scanning in axial and/or circumferential orientation.

An overview of the next generation MEC-Combi Crawlers and Pipescanners with the various add-on inspection techniques is shown above.

Riser, Caisson and Conductor Inspection

The **MEC-MPS** series of internal and external scanners is used for the splash zone and subsea inspection of rigid risers, caissons and conductor pipes including through the

The MEC-Hug Crawler is a self-driving scanner developed not only to deploy the MECFIT™ inspection technique but also to address the specific challenges of accessing and inspecting flexible and rigid risers at their working locations

neoprene coating and Monel clad. With general marine growth removal, they allow the smooth transition from the topside directly into the splash zone and subsea area without a break in the continuity of scanning.

Typically equipped with single Ultrasonic sensors for contact measurement for absolute wall thickness, the MEC-MPS series of scanners can also be incorporated with a specially developed Ultrasonic electronics and sensor array able to permanently measure the absolute wall thickness in stand-off up to 0.75" distance when a couplant is present under water with a surface that has been sufficiently cleaned.

The capabilities of the MEC-MPS scanners include:

- Inspection of heavy pipe wall of up to 1" wall thickness
- Inspection of coated and cladded assets
- External and internal localised wall loss detection
- High sensitivity and reliability for corrosion mapping
- Limited preparation prior to inspection with availability for integrated cleaning
- Deployed by divers or rope access personnel

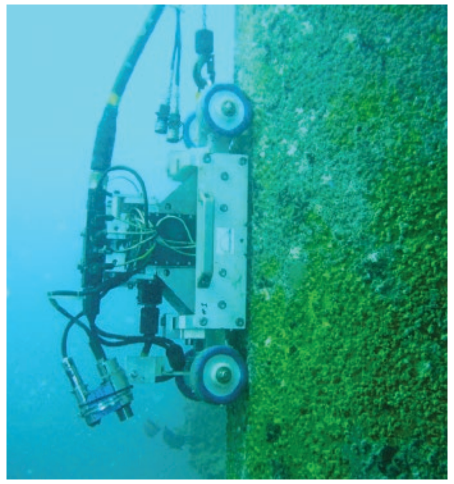


DIAGRAM 5 – MEC-MPS200+ MARINISED SCANNER PERFORMING THE SCANS ON 30" CONDUCTOR PIPE

Flexible Riser Inspection

The MEC-Hug Crawler is a self-driving scanner developed not only to deploy the MEC-FIT™ inspection technique but also to address the specific challenges of accessing and inspecting flexible and rigid risers at their working locations. After deployment by divers or ROV, the MEC-Hug Crawler embraces the flexible riser and moves along the pipe to perform the external inspection. A change over of the sensor system enables the MEC-Hug Crawler to be used for the inspection of rigid risers.

The capabilities of the MEC-Hug Crawler include:

- Inspection of flexible risers with OD ranging from 4" to 12"

DIAGRAM 6 – MEC-HUG CRAWLER BEING DEPLOYED FROM THE INSTALLATION TO INSPECT FLEXIBLE RISERS IN THE NORTH SEA

- Wall loss, crack and corrosion detection at first and second tensile layers or third zeta layer with wire gap display
- Deployed by divers or ROV

Subsea Structure and Ship Hull Inspection

The MEC-Combi Crawler is a self-driving scanner that combines the MEC technique with other supporting inspection techniques such as Ultrasonic, PEC, laser and camera system for the inspection and lifetime assessment of subsea structures such as platform legs, risers and caissons as well as flat surfaces like ship hulls. Matrix wall inspection data in terms of defect size, severity of wall loss and locations is achieved for the fitness for service analysis.

The capabilities of MEC-Combi Crawler include:

- Inspection of heavy pipe wall
- External and internal wall loss detection
- Fast scanning of structures from topside down to subsea areas
- Corrosion mapping with matrix data
- Deployed by divers, rope access personnel or ROV

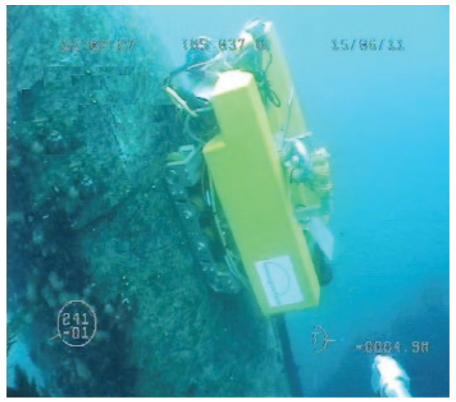


DIAGRAM 7 – MEC-COMBI CRAWLER INSPECTING A PLATFORM STRUCTURAL LEG IN THE NORTH SEA

Subsea Pipeline Inspection

The MEC-Combi PipeCrawlers are used for the external fast scanning of non-piggable subsea pipelines. They are self-driving scanners with hydraulic driven wheels to enable the inspection of subsea pipelines and flexible pipes in the axial and circumferential direction.

The MEC inspection technique is combined with Ultrasonic sensor array, Pulsed Eddy Current and laser system to provide matrix wall inspection data in terms of defect size, severity of wall loss and locations for the fitness for service analysis.

The capabilities of MEC-Combi PipeCrawlers include:

- Inspection of coated pipelines
- External and internal wall loss detection
- Mapping of external and internal pipe surface condition
- Corrosion mapping with matrix data
- Diver or ROV deployed

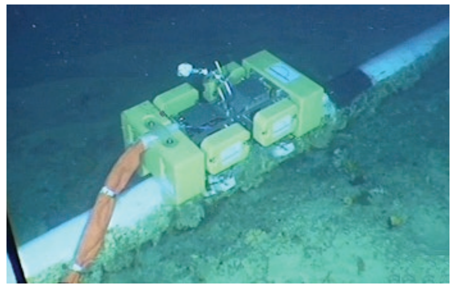


DIAGRAM 8 – MEC-COMBI PIPECRAWLER INSPECTING A SUBSEA PIPELINE IN AUSTRALIA

Mooring Line Inspection

The MEC-Wire Scan is a self-driving scanner with a specifically developed flexible Eddy Current sensor array system able to penetrate through 35mm stand-off for the detection of cracks, localised defects and galvanization removal from wires of the mooring lines.

The flexible Eddy Current sensor array system enables larger circumferential area coverage to accommodate the thickness of the mooring line's polyethylene outer sheath as well as a change in the diameter in case of a repair patch.

Your Inspection Solution Provider

The high performance subsea inspection techniques combined with the next generation of sophisticated MEC-Combi Crawlers and Pipescanners provide our clients with optimum and unique inspection solutions to meet the niche challenges presented in the deep water operations in the worldwide oil and gas industry.

Supported by an internal R&D team consisting of highly qualified engineers and development technologists with expertise and know-how in advanced NDT technologies and

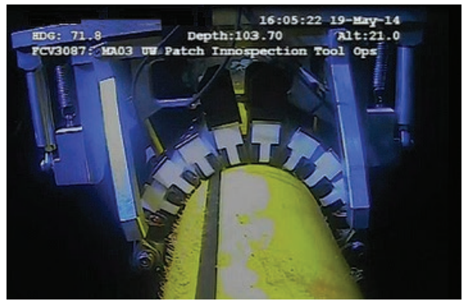


DIAGRAM 9 – MEC-WIRE SCAN WITH FLEXIBLE SENSOR ARRAY DURING THE INSPECTION OF PATCHED MOORING LINES

application development to inspection tasks, the advanced and innovative inspection solutions and services provided by Innospection are unlimited. Whatever your subsea inspection challenges, Innospection is your solution provider.

Contact

Innospection Limited
Unit 1, Howemoss Avenue
Kirkhill Industrial Estate, Dyce
Aberdeen, AB21 0GP
United Kingdom

Andreas Boenisch,
Managing Director

Sebastian Hartmann,
Business Development & Sales Manager

Tel: +44 (0)1224 724744
Email: info@innospection.com
Web: www.innospection.com

What Drives Inspection?

John Hancock, Editor

A growing market means a growing sector which means a growing demand for safe and responsible operations

Oil and gas operators and consultants are becoming increasingly aware of the rate in which conventional wells are drying out… As a result, oil and gas firms are looking to squeeze every last drop of reserves from the nooks and crannies of the ocean, in hard-to-reach, ultra-deep places

EXCEPTING SAFETY, any overview of offshore oil and gas operations will start with the money because that's what business is about: bringing investment, time and capabilities together to generate value. Investments in this sector are colossal while the time over which any return might be realised spans decades rather than years and capabilities come from across the engineering spectrum and beyond. Over and above the ability to locate, access and produce oil and gas, there is the need to keep all of the expensive equipment and infrastructure involved in the process running smoothly. The process to which this task is entrusted is inspection, repair and maintenance (IRM) and it is with the first stage of the IRM process, inspection, that this paper will be concerned. But first, to understand why such an expensive undertaking is worthwhile, we need to take a step back and look at the underlying driver of demand powering growth for the whole energy sector and, in this case, offshore oil and gas.

Demand Drives Development

Global demand for energy continues to grow with little prospect that sustainable or renewable resources will be sufficiently developed to fill that appetite in the near future. That reality generates the incentive to find further reserves of carbon based fuels. Much of the world's hydrocarbon fuel reserves have been located but not all are yet exploited. There are several reasons for this but the most frequently cited is that, as yet unexploited reserves tend to be in inaccessible or inhospitable environments… or both. There are few environments more inaccessible or hostile than the oceans but there are significant reserves of oil and gas to be found at ever increasing distances from land, far beneath sea-beds that are themselves deep below the ocean's surface. It adds up to a significant challenge.

All that said, demand growth will not be equal across the sector so that while, as BP Energy Outlook 2035[1] puts it, "… global energy consumption is expected to rise by [only] 41 per cent from 2012 to 2035 – compared to 55 per cent over the last 23 years (52 per cent over the last twenty) and 30% over the last ten... Ninety five per cent of that growth in demand is expected to come from the emerging economies, while energy use in the advanced economies of North America, Europe and Asia as a group is expected to grow only very slowly – and begin to decline in the later years of the forecast period [to 2035]." In the same paper, BP Chief Economist Christof Rühl says: "This process shows the power of economic forces and competition. Put simply, people are finding ways to use energy more efficiently because it saves them money." The paper also records that while demand for oil might only grow at 0.8% a year during the period in question, demand for natural gas will rise at 1.9% a year – more than twice as fast.

Developments Becoming Worthwhile at the Right Price

Notwithstanding all of the above, the underlying driver of demand continues to grow. In June 2013 the United Nations[2] calculated that the current world population of 7.2 billion was likely to increase by 1 billion over the next 12 years and to reach 9.6 billion by 2050. So even if the rate of demand growth might not be as frenetic in the years ahead as it has been in the recent past, demand will continue to grow and prices, although falling at the time of writing, will rise in the long-term, unless supply can be increased at a rate to match demand growth. This is important because a rising price for the product will render once uneconomic reserves now viable. Also, to meet today's energy demands, producers will consider and test any potential reserves wherever they might be located – including some inaccessible or inhospitable environments… or both. There are few environments more inaccessible or hostile than the oceans but significant reserves of oil and gas are to be found at ever increasing distances from land, ever greater depths beneath the oceans and ever further beneath the earth's surface.

When the price is right and can be realised, it becomes worth undertaking extraordinary engineering and technology programmes in pursuit of a product. And so it is with deep sea exploration for and production of oil and gas. This has spurred enormous growth in offshore oil and gas accompanied by incredible engineering, construction and supply chain challenges. According to some predictions, the subsea oil and gas market is expected to double by 2018 to £40 billion, from £20 billion in 2013. Effort and activity on this scale requires a robust IRM process to ensure its continued efficient operation because, with ever increasing and aging fleets of complex equipment being located on the ocean's surface and on the seabed in conditions that vary from challenging to hazardous, the requirement for services that can support competent inspection, repair and maintenance activities will not simply continue but will grow.

RISERS IN THE NORTH SEA

Challenges

There will be no shortage of challenges in this next phase of global hydrocarbon recovery. As Sarah Blackman in the June 2012 issue of *Offshore Technology*[3] explained; "The days of cheap and easy-to-drill oil are over. Now comes the hard work of finding and producing oil from more challenging environments.

Those were the words of ExxonMobil in 2005 and seven years later, oil and gas operators and consultants are becoming increasingly aware of the rate in which conventional wells are drying out… As a result, oil and gas firms are looking to squeeze every last drop of reserves from the nooks and crannies of the ocean, in hard-to-reach, ultra-deep places."

And it isn't just the locations that are challenging – the engineering is being stretched in every possible way, extending the life, reach and capability of current installations.

Responsibility and the Environment

But with all of these extensions, the regulatory authorities are making sure that appropriate support regimes are in place to ensure safe and environmentally responsible as well as efficient and profitable processes. For instance, the UK Health and Safety Executive (HSE) 'Ageing and Life Extension Inspection Program, 2010-2013'[4] was designed to, "ensure that the risks associated with ageing and life extension are controlled effectively by the offshore industry… to develop a common approach to the management of ageing installations and life extension [and] ensure the continued safe operation of all ageing offshore installations."

One further consideration in any engineering extension programme is that, as part of an operator's environmental responsibility, any changes, upgrades or maintenance have to be carried out to or completed with, as Dr Brian Twomey put it in his June 2012 presentation 'Life Cycle of an Oil & Gas Installation'[5], "full consideration of future decommissioning, disposal and operating pollution."

In any of the developments outlined above, there will be a need for operators to know as much as possible about the condition and resilience of their equipment and structures and that will require sound inspection techniques.

Engineering and Infrastructure

Francis Slade, Staff Writer

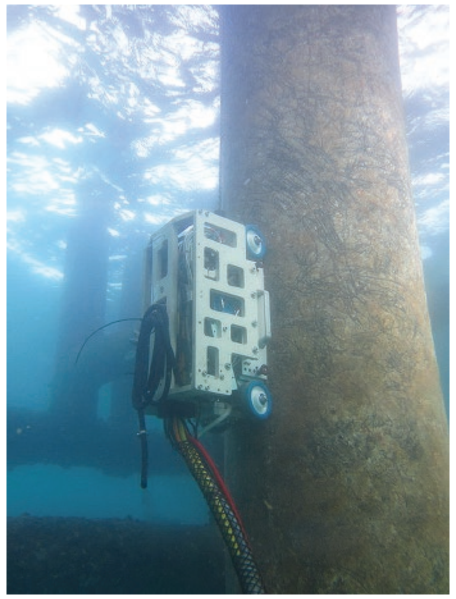
The offshore sector puts engineering and inspection to the test at every turn.

The engineering employed in offshore oil and gas production is both costly and expensive and, if it fails, has the potential to seriously damage the environment as well as the finances and reputation of the operator. Thorough and routine inspection using the best equipment available will significantly reduce the risk

THE COVERALL term 'subsea' describes oil and gas exploration and production operations under water. However, it doesn't do justice to the diversity and complexity of operations and engineering to be found in offshore oil and gas. In the previous article, John Hancock alluded to some of the environmental challenges that face subsea oil and gas exploration and production processes. But there are also engineering challenges associated with this sector not least because of the extremes to which its key components are often taken. So what are these key components that make up offshore oil and gas?

Expensive Equipment

We cannot talk about the offshore subsea energy sector without talking about equipment and very expensive equipment at that. There is a reason for that enormous cost. Given the tremendous demands of the environment in which the sector operates, the enclosed nature and isolation of most installations, everything has to be built to the highest structural, safety and operational integrity levels. But if something does go wrong, there aren't many places to go to and if something ceases to function, the cost in lost production and/or environmental damage can be enormous. It is, therefore, no surprise that a significant part of any development and operational package would include scheduled inspection and maintenance programs. Equipment in these conditions must be reliable enough to safeguard the environment, and make the exploitation of subsea hydrocarbons economically feasible, plus operators must have the means to monitor the equipment to ensure that it continues to deliver on all of those attributes.



INSPECTING OFFSHORE CONDUCTOR PIPES

Platforms

Perhaps the best-known offshore engineering achievements are the enormous platforms and associated structures from which the drilling and production processes are achieved and managed. In the first place, there are two types of offshore structure, fixed and floating. There are also man-made islands but, for the purposes of this paper, we will stick to the familiar structures of… a platform, a wellhead, associated equipment and the pipe work that joins it all up and connects the complex to a loading facility or the mainland. While we need not go into details of the various types of fixed and floating platforms, one thing common to all of them is that significant parts of their structures are underwater and that poses particular problems when it comes to inspecting them in order to monitor their condition and resilience.

But even these platforms include an array of different engineering solutions to the challenges of winning oil and gas product from wells located under water and tapping reserves far beneath the seabed. And subsea production systems can range in complexity from a single satellite well with a flow line linked to a fixed platform, FPSO or an onshore installation, to several wells on a template or clustered around a manifold, and transferring to a fixed or floating facility, or directly to an onshore installation[6].

CAISSONS IN THE NORTH SEA

Pipelines

Platforms are not the only structures on or in the sea. Pipelines are also candidates for the most important, if largely invisible, components in any offshore energy complex. After all, they transport the product to where its value can be realised. But pipes are vulnerable and can be subject to considerable stresses if not properly managed. And stresses can eventually lead to joints separating which, in turn, can lead to the worst nightmare of any offshore operator – crude oil leaking into the ocean. Only a robust inspection regime will alert an operator to changes and/or deterioration in the fabric or condition of a pipe and thereby possibly avoid the incalculable cost of a failure.

Equipment at the Wellhead

The pipe, of course, transports product away from the well head and accompanying Christmas tree. Oilfield Wiki describes the Christmas tree[7]… "In petroleum and natural gas extraction, a Christmas tree, or 'tree'… is an assembly of valves, spools, and fittings used for an oil well, gas well… and other types of wells. It was named for its crude resemblance to a decorated tree… Tree complexity has increased over the last few decades… This is especially true in subsea applications where the resemblance to Christmas trees no longer exists given the frame and support systems into which the main valve block is integrated… The primary function of a tree is to control the flow into or out of the well, usually oil or gas. A tree often provides numerous additional functions… and well-monitoring points." Again, the need for a sound inspection process is clear.

Subsea Processing

And then of course there is the latest development for offshore oil and gas production – subsea processing, moving processing and the paraphernalia that accompanies it, down to the seabed. It is development that has been dubbed 'The Game changer', as in the Offshore Magazine article of the name[8] which explains, "…the short-term future for subsea processing is most likely to involve equipment being installed on fields to de-bottleneck topsides facilities. These fields are less likely to be long-distance tie-backs or low-pressure reservoirs and more likely to be deepwater fields or fields with high water content." The article continues to add that, while the range of areas where subsea processing is likely to be used has decreased, the likelihood of operators using the technology has increased, with nearly all of them expecting to install some subsea processing equipment within the next five years. In the terms of this paper, that means more equipment to inspect.

The engineering employed in offshore oil and gas production is both costly and expensive and, if it fails, has the potential to seriously damage the environment as well as the finances and reputation of the operator. Thorough and routine inspection using the best equipment available will significantly reduce the risk of failure and increase the efficiency of processes; and that must be worth pursuing.

An Eye on the Future

Peter Dunwell, *Correspondent*

Inspection and maintenance can add long-term value to structures and equipment.

There are some particular business reasons why inspection and maintenance are desirable. Right at the top of that list, for any responsible company, will be safety

A Growing Market

The challenges facing inspection as part of an IRM programme are certainly growing with increasingly challenging environments, complex engineering, life extension and ever tightening regulations to be considered (see previous articles). But as well as these qualitative requirements, there is also a more traditional quantitative growth as the amount of equipment and infrastructure also grows. Following a period in which the 2009 financial crisis and the Gulf of Mexico oil spill limited growth in subsea hardware spend, “Douglas-Westwood (DW) forecasts global subsea hardware Capex will total $117 billion (bn) between 2014 and 2018. This represents growth of more than 80% compared with the preceding five-year period. In 2013, subsea tree installations were lower than expected with delays in crucial projects off Brazil and West Africa. However, DW predicts an increase through to 2018, with major manufacturers reporting strong backlogs.”[9]

In an earlier report last year, DW[10] noted that the IRM market is seeing huge growth thanks to the sheer magnitude and age of global subsea infrastructure. Also, unlike field development and production, IRM is largely unaffected by the oil price: it is a burgeoning subsector. Underlying this growth, as well as the sheer size of the sector, is the fact that, in any process where costly and complex equipment is used, a key priority will be to avoid failure. Put simply, equipment that isn’t working isn’t generating revenue. As importantly, in a process, when one piece of equipment fails, the whole process fails. This is one of a number of reasons why access to a reliable and effective inspection to ascertain current condition and identify flaws before they become failures, is critical to the management of any offshore subsea energy installation. And these days, no management program can ignore the environmental dimension. Dr Brian Twomey has explained this as[11]; “Maintenance [should be] carried out with full consideration of future decommissioning, disposal and operating pollution.”

Reasons to be Careful

While there are many reasons why investment in a sound inspection and maintenance regime is money well spent, there are some particular business reasons why inspection and maintenance are desirable. Right at the top of that list, for any responsible company, will be safety. It is the first duty of any business operating in any environment, let alone an environment as hazardous as that where offshore oil and gas operates, to ensure the safety of its workforce. Safety is also a key focus of regulators around the world typical of which would be the 2013 EU Directive 2013/30/EU[12] on the safety of offshore oil and gas operations, which followed the April 2010 Gulf of Mexico spillage and has the objective to reduce as far as possible the occurrence of major accidents related to offshore oil and gas operations and to limit their consequences.

After safety, any inspection regime should contribute information to an overall asset integrity management programme, described by Robbie Williamson of Celso Raposo as, “a continuous process of ‘Knowledge and Experience Management’ applied throughout the lifecycle to assure that the asset/system is managed cost effectively and safely and remains reliable and available, with due focus on personnel, assets, operations and environment.”

Of course, notwithstanding all of the above, a business still has to make a profit. Fundamental to this are the two elements of efficiency and productivity. Once again, in this context, a thorough inspection programme will ensure that up-to-date knowledge about the condition of equipment and structures is available to enable operators and engineers to instigate preventative and pre-emptive maintenance repair and renewal actions. It is not only the cost of failure in lost productivity but also the long-term cost of inefficiency which can increase running costs across the board.

A Longer Useful Life

Throughout this paper, we have alluded to the practice of extending the operational life, reach

OFFSHORE STRUCTURES

and capability of structures and equipment in offshore oil and gas. These concepts are interlinked. All equipment has a ‘design life’, the period of operation or number of operations for which the designer and manufacturer anticipated the equipment having to function. Today, with operators seeking to extend the working life of equipment to further exploit a reserve or to exploit a new technology that can extract more product from a given reserve, a lot of equipment is being operated well beyond its design life. That is absolutely fine; but there are conditions that will need to be met before the end of design life.

The Journal of Petroleum Technology article ‘Offshore Oil and Gas Installation – Aging and Life Extension’[14] explains, “In the end-of-life stage, the safe operating limits for the equipment are approaching, advanced inspection techniques are required...” However, the article continues to say that the key to longer-term reliability and safety is to establish effective management systems early on, so as to prolong the mature stage, because leaving life extension programmes until later stages requires considerably more effort and cost. The sensible thing is to monitor and maintain equipment properly throughout its operational life to ensure that, if required, it will remain efficient and usable for longer.

There are many safety and operational reasons to avoid failure but perhaps the one that should most exercise the minds of operators is the reputational risk which might not only have an adverse effect on revenue but could also affect the share price and ultimately make a business vulnerable to takeover.

Given the financial, reputational and operational costs that can result from any failure, for the offshore oil and gas sector, prevention is definitely better than cure. And in this respect, along with a robust program of risk assessment, risk management, maintenance and renewal, inspection is an absolutely critical component in the overall running of an operation.

Challenges to Inspection Techniques

***John Hancock**, Editor*

The variables that inspection has to monitor and the need to keep up with progress in engineering and regulation.

Aging is not about how old the equipment is; it is about what is known about its condition, how that is changing over time, and how effectively the associated risks are being managed

Most variables that determine the nature and frequency of an inspection programme will be situational (such as environment and geology) or event driven (such as weather, and equipment wear and tear). One variable, however, is linear and that is the life stages through which any offshore oil and gas field and installation will pass. Because the anticipated life of installations is measured over decades, it could be easy to neglect situations that might be seen as too far ahead in time to warrant consideration today. However that would be wrong because consideration of the long-term future will usually mean that inspection and maintenance processes today will not only add value to current operations but will make more feasible and cost-effective any extended operations beyond the end of design life.

Asset Life and Aging

The life stages of an offshore oil and gas field are well documented but can be summarised. In simple terms the offshore oil and gas life-cycle goes from exploration and evaluation of the reserves to developing the field, building the subsea structures, production and ultimate decommissioning and dismantling. Any programme to extend the life of an installation would extend the production stage of the life-cycle and defer decommissioning and dismantling. But the management of life extended structures and equipment is a specialist process in its own right. Engineer Live, in an article 'Repairing and strengthening of ageing offshore structures'[15] confirms that "Structural integrity management is an increasingly important element of the oil operator's offshore engineer's role… Should any significant change of the structural integrity of the structure be suspect then… an appropriate repair strengthening plan must be implemented sooner rather than later." Of course, the best way to monitor for change in structural integrity is through an effective inspection programme. As The Journal of Petroleum Technology, February 2012 edition[16] explains. "Aging is not about how old the equipment is; it is about what is known about its condition, how that is changing over time, and how effectively the associated risks are being managed."

Regulators also take especially seriously the management of aging and life extended assets. In the UK, the HSE's (Health & Safety Executive) KP4 inspection programme[17] seeks to ensure that risks to asset integrity arising from ageing and life extension are adequately controlled.

Access Challenges

In all of these requirements and the environmental and engineering factors already discussed, inspection techniques have to overcome a number of challenges and constraints which make visual inspections difficult and, as importantly, unable to deliver the quality of conditional information required by either operators or regulators today. Access is often the first challenge. As Robert Lamb writing in How Stuff Works[18] put it, not only is "… most of the world's petroleum trapped between 500 and 25,000 feet (152 and 7,620 meters) under dirt and rock… [but also]" not all oil deposits are conveniently located under land or below shallow waters which means that, while many of the more easily accessible fields are already well into their productive life, new reserves are increasingly located beneath deep oceans and even beneath the Arctic ice.

The Deepwater Challenge

Depth can be a challenge in its own right. In a May 2013 interview with O&G Next Generation (no longer available online), Dr Neil Thompson, Ex-President of the National Association of Corrosion Engineers (NACE) explained that hostile environments are often associated with offshore pipelines and facilities. As production goes deeper, the environments of production almost always become more hostile (temperature and pressure) and often with higher concentrations of aggressive substances (e.g. H2S, CO2, solids, water). Words like 'hostile' and 'aggressive' suggest that the challenges facing deep sea facilities and inspection are more than simply intellectual. In these conditions, equipment will be under ever greater levels of stress and the consequences associated with failure will be ever more daunting. Not only does the equipment used require more frequent and thorough inspection, but the inspection techniques themselves have to be sufficiently robust to cope with the harsh conditions. Yet the challenge of depth cannot be avoided. Total has calculated[19] that, "More than 5% of the world's liquid hydrocarbon resources are believed to lie in deepwater reservoirs. Estimated at some 300 billion barrels these resources could make a major contribution…"

Other challenges to high-quality inspection can include the weather and sea conditions, the topography of the seabed and, of course, the usual commercial constraints of time and cost.

CAISSONS IN THE NORTH SEA

Inspection Techniques Have to Keep Up

To meet these various and significant challenges, inspection techniques have to be developed to a high degree. As Julian Turner puts it in the opening lines of his article on cutting-edge offshore inspection techniques[20], "New technologies that minimise revenue loss and protect both personnel and the environment are transforming offshore inspection best practice." However, even the best inspection techniques cannot identify every possibility of failure. In her presentation on risk-based inspection, Susannah Turner of Penspen Integrity[21] explains that while inspection is good at identifying damage or the onset of deterioration, it cannot predict instantaneous failure, although a good inspection regime will reduce levels of uncertainty and indicate possible failure triggers. She advocates a process of risk based inspection to ensure that the latest inspection techniques are applied in a structured regime that takes account of likely threats and deterioration.

Even the best asset management regime using the latest technology and methodology will not guarantee against failure but, in a world where costs in general and the costs of failure in particular are so high, operators will wish to take whatever steps they can to minimise the risk of failure and maximise the likelihood of pre-empting failure through deterioration or wear and tear. High quality inspection remains the best weapon in an operator's monitoring and management regime.

References:

[1] BP 'Energy Outlook 2035' http://www.bp.com/en/global/corporate/press/press-releases/energy-outlook-2035.html

[2] UN 'World population…' http://www.un.org/apps/news/story.asp?NewsID=45165#.VG4N_vmsXAk

[3] Offshore Technology http://www.offshore-technology.com/features/featurerisky-business-deepwater-drilling-north-sea/

[4] UK HSE http://www.hse.gov.uk/offshore/aim-ageing.htm

[5] Dr Brian Twomey http://www.ccop.or.th/eppm/projects/40/docs/3%20BT%20Life%20cycle%20of%20an%20oil%20field%20&%20decommissioning%2013June12%20issued.pdf

[6] Wikipedia http://en.wikipedia.org/wiki/Subsea_%28technology%29

[7] Oilfield Wiki http://www.oilfieldwiki.com/wiki/Christmas_tree_(oil_well)

[8] Offshore Magazine 'Subsea processing – the gamechanger' http://www.offshore-mag.com/articles/print/volume-63/issue-11/technology/subsea-processing-ndash-the-gamechanger.html

[9] Douglas-Westwood, 'World Subsea Hardware Market Forecast 2014-2018' http://www.douglas-westwood.com/shop/shop-infopage.php?longref=1373#.VHNWcPmsXAk

[10] Shipping & Marine http://www.shippingandmarine.co.uk/article-page.php?contentid=17627&issueid=491

[11] Dr Brian Twomey http://www.ccop.or.th/eppm/projects/40/docs/3%20BT%20Life%20cycle%20of%20an%20oil%20field%20&%20decommissioning%2013June12%20issued.pdf

[12] EU Directive 2013/30/EU http://ec.europa.eu/energy/oil/offshore/standards_en.htm

[13] Robbie Williamson, Celso Raposo http://www.subseauk.com/documents/dnv%20-%20robbie%20williamson.pdf

[14] The Journal of Petroleum Technology http://www.mydigitalpublication.com/article/Offshore+Oil+and+Gas+Installation%E2%80%94Aging+and+Life+Extension/951953/0/article.html

[15] Engineer Live http://www.engineerlive.com/content/21403

[16] The Journal of Petroleum Technology http://www.mydigitalpublication.com/article/Offshore+Oil+and+Gas+Installation%E2%80%94Aging+and+Life+Extension/951953/0/article.html

[17] Oil & Gas UK http://www.oilandgasuk.co.uk/ageing_and_life_extension.cfm

[18] How Stuff Works http://science.howstuffworks.com/environmental/energy/offshore-drilling.htm/printable

[19] Total http://www.total.com/en/energies-expertise/oil-gas/exploration-production/strategic-sectors/deep-offshore/conquering-ocean-depths-extraordinary-potential-and-extreme-challenges

[20] Offshore Technology http://www.offshore-technology.com/features/feature-oil-gas-safety-inspection-monitoring-topside-subsea/

[21] Penspen Group http://www.subseauk.com/documents/st%20spim%20presentation%20for%20pdf.pdf

Offshore Technology Reports... the leading specialist combined online research and networking resource for senior upstream oil and gas industry professionals.

- Up to the minute Industry and Technology information available to all site users on a free of charge open access basis.
- Qualified signed up members are able to access premium content Special Reports and interact with their peers using a variety of advanced online networking tools.
- Designed to help users identify new technical solutions, understand the implications of different technical choices and select the best solutions available.
- Thought Leadership – Advice and guidance from internationally recognised upstream oil and gas key opinion leaders.
- Peer Input – Contributions from senior upstream oil and gas industry professionals.
- Independent Editorial Content – Expert and authoritative analysis from award winning journalists and leading industry commentators.
- Unbiased Supplier Provided Content.
- Designed to facilitate debate.
- Written to the highest professional standards

Visit http://www.offshoretechnologyreports.com/