MEETING THE DECOMMISSIONING CHALLENGE

Addressing the cost and safety issues of abandoning wells

Ikon SCIENCE

Table of Contents

Introduction

At the same time as the oil and gas industry is expanding into new basins and new unconventional plays, mature basins around the world are offering fresh challenges at the end of field life. Decommissioning creates no further revenue to operators and the associated costs and risks are high. Addressing these challenges is urgent and the potential to avoid high costs is significant.

Decommissioning and the UKCS

A large number of oil and gas assets in the North Sea are coming to the end of their field life. The decommissioning and removal of the associated infrastructure presents a huge challenge and must be carried out safely, securely and cost effectively.

According to Oil and Gas UK, the projected decommissioning spend between 2017 and 2025 on the UK Continental Shelf is $20-30 billion, distributed between almost 2,500 wells[1]. Well plugging and abandonment (P&A) is the largest component of this decommissioning expenditure, accounting for almost 50% of the total cost.

Current legislation means the UK taxpayer will supply half of the multi-billion pound burden for dismantling these rigs, platforms and old infrastructure. The government's priority, therefore, is to reduce costs effectively, while maintaining high safety and environmental standards. Of course, conducting operations in the most safe and cost-effective manner is equally important to operators.

Global decommissioning

Southeast Asia, Latin America, West Africa, the Arabian Gulf, Egypt, India, China, and Australia are all beginning to face the emerging challenges of decommissioning. Most governments have begun an initial look at decommissioning, although their timelines may be decades behind Europe and the US.

Brazil, for example, has removed less than 5% of its offshore platforms, 42% of which are more than 25yrs old. A further 38% of their offshore platforms are between 15 and 25 years old. Clearly, decommissioning will become a pressing issue in Brazil over the next 10 years[2].

By contrast, there are over 2500 offshore oil installations across the Southeast Asia region of which almost 800 are approaching the end of their design life, or have already exceeded it. Cost estimates for the eventual decommissioning of these regional assets range from $30-60 billion[3].

Similarly, Nigeria and Angola hold the fastest growing decommissioning markets in West Africa. It's estimated that by 2020 Nigeria will have performed 107 platform removals, compared to just 1 in the Ivory Coast[4].

Decommissioning status today

With all this global activity, the maturity of the UK continental shelf (UKCS) puts the focus on the UK to drive decommissioning innovation.

Many factors contribute to safe and successful operations, but key are:

1. Governmental legislative framework
2. Incorporating lessons learnt from already completed projects
3. Developing specialist tools and equipment
4. Encouraging dedicated decommissioning contractors
5. Establishing best practice for well abandonment and monitoring

To date, much of the attention in decommissioning has focused on the big-ticket items, such as top side removal, rigless methodologies (removal without the need for a jack-up rig), and new materials for permanent barriers (e.g. Thermite). All of these technical innovations have led to significant cost reductions.

For example, at Brent Delta the removal of the 24,200-tonne platform was performed in a single lift using the Pioneering Spirit. A low-cost method of rigless well P&A was also trialled onshore by Centrica in Canada in 2016. The trial results demonstrated that this technology could potentially reduce well P&A costs by more than 50%[5].

Further innovations in decommissioning have also been found by collaborating and drawing on experiences from industries outside of the oil and gas supply chain, where risk management and risk assessment techniques are of paramount importance in delivering cost-efficiencies. Projects explored include the construction of Cross Rail in the UK, and several in the nuclear industries. Many other new technology pilot programmes are demonstrating cost savings achieved through collaborative working.

Greatest decommissioning cost impact

Though substantial cost reductions are being made, they only contribute to a fraction of the overall decommissioning costs. The largest capital expenditure in decommissioning – accounting for 50% of costs - is on the well plugging and abandonment workflow[6]. Clearly, this is a high-value place to focus.

Researching and applying new and efficient technology for P&A operations is the clearest way to cut down on the number of days required to complete the operation and to minimise costs.

In the decommissioning of wells, the focus is on ensuring there is zero risk of integrity failures resulting from the abandonment operations. The P&A process itself is simple to summarise: to permanently isolate and seal a well. However, the long term success of these abandoned wells is dependent on the sealing requirements, which become critical since the cost risk and environmental impact of returning to re-abandon a well is a major concern.

To prepare a well to be closed permanently, log data, pressure data and any other relevant data such as daily drilling summaries are combined to determine plug/slot placement, the integrity of the formation and the current condition of the wells. Well P&A is typically driven by well engineers, with variable input from G&G departments, depending on the company size and their resource constraints.

Understanding Formation Pressure

A critical element in designing a well abandonment program is assessing whether managing the virgin pressures is required. The pressure depletion effects of production and, in some cases, induced strata compaction, may need to be incorporated into the P&A plan. A geological assessment of the field and its surrounding area is needed to understand the potential for communication within and between reservoir horizons and the possibility for future fluid movement.

At the pre-drill stage much of this information should be known, given that the assessment of the formation pressures, overburden, and fracture strength are required for well planning, but this assessment may only be applicable on a well-by-well basis. Throughout the life cycle of a field the state of a reservoir will change: pore pressures may become depleted and/or recharged, potentially leading to fault reactivation; overburden may compact and thermal changes may also occur.

Therefore, having an understanding of the ambient pore pressures, recharge pressures, and the timescales over which these may occur, at both a regional and local scale, during the abandonment planning procedure will be invaluable.

Reducing well plugging and abandonment costs and the associated subsurface risks during decommissioning is a vital emerging challenge in the oil and gas industry. Leveraging available data and knowledge offers the chance for industry-scale innovation and costs savings. And the greatest potential for rapid learning, iteration and value impact today lies in the mature UKCS.

Software and Services to Improve Subsurface Risk Analysis

To help meet the decommissioning challenge, Ikon Science is combining a substantial and unique database of well data and analysis with Ikon's industry-leading software technology. The initial focus will be on the UK Continental Shelf.

Ikon has analysed over 4,000 UKCS wells and a further 2000 on a proprietary level. Bringing to bear Ikon's unique ability to understand and model geopressure and stresses, the goal is to reduce well plugging and abandonment costs.

With a 15 year track record of subsurface geoscience innovation, Ikon has developed considerable expertise in solving international oil and gas E&P challenges. With tailored workflows and familiarity with regional and local data access protocols and formats, Ikon can quickly progress projects.

Three areas of subsurface evaluation offer substantial potential to improve the safety and value of P&A campaigns and these will be explored here.

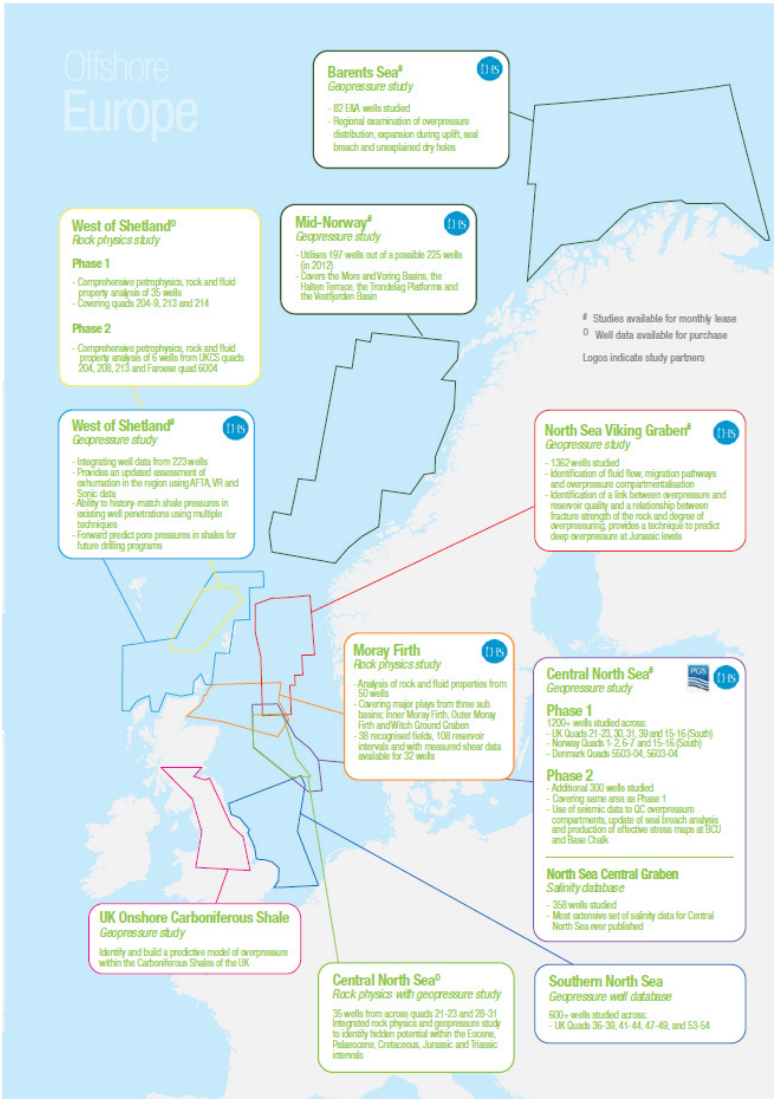

Figure 1 Regional study databases from Northern Europe

Overburden flow risk

Abandonment of wells is requires the isolation of rock formations that have flow potential. An assessment of flow potential of individual formations penetrated by a well is a key input to the design of well barriers[7].

Flow potential originates primarily from permeable formations and a pressure differential to other formations or the surface. A rock with low or no permeability, like shales and chalk, may, however, also exhibit flow potential (e.g. if it has natural or induced fractures), in which case these should be isolated[8].

Permeable or fractured formations that are water bearing and hydrostatic are not flow potential zones. The decision to isolate shallow normally-pressured water-bearing zones in a well will depend on local conditions, on a well-by-well basis.

Applying UKCS decommissioning rules

The decommissioning of offshore oil and gas infrastructure on the UKCS must meet with the requirements of the Petroleum Act 1998. Following these guidelines in the strictest sense for a P&A campaign, however, can lead to poor technical decisions.

In the mature basins of the Southern North Sea (SNS), guidelines may dictate that a surface plug is required to separate the Upper Cretaceous and Triassic sands and a secondary plug to separate the deeper Leman Sands. Within these formations the Cretaceous units are commonly normally pressured since they often sub-crop on the seabed and are hydrocarbon free. As such, there is little technical justification for placing a shallower barrier above the Cretaceous and Triassic Bunter.

Furthermore, the existing wells available may have been drilled over- or under-balanced and hence the virgin pore pressure fracture gradient plans are invalid, specifically with changes in the reservoir and overburden during production.

Services to safely and cost-effectively meet regulatory requirements

To address a mis-match between regulatory requirements and the specific technical needs of a particular well in a fast and cost-efficient manner, the use of regional datasets becomes invaluable.

Ideally a single database will contain:

- Pressure
- Rock properties
- Temperatures
- Geological and burial histories
- Compaction behaviour
- Overpressure maps
- Fault and top seal integrity
- Structural and stratigraphic information

Considerations of pressure connectivity may not be justified based on a few local wells with variable data quality (most production wells do not have full well datasets, unlike exploration wells), which can impact the decision on which strength of plugs are required.

Detailed petrophysics, using standardised workflows, are crucial for the identification of isolation between distinct zones because each field over an area will be different. Establishing the nature and sealing capacity of shales and predicting whether they will squeeze and provide self-healing annular barriers is essential, particularly if there have been any previous abandonment issues.

Detecting gas in the overburden formations can also be challenging not only through reviewing well reports, drilling histories and casing programmes, but the requirement to integrate with logging data such as, resistivity, pulsed neutron logs which are a key part of G&G workflows.

Detailed reviews of the legacy development drilling and previous abandonments procedures for slot recovery is also critical, this is typically done by well engineering teams but must be considered or discussed between subsurface and well teams, to help identify the right compromise between maximising hydrocarbon recovery during the remaining life-of-field and cost-effective well abandonments.

Using this foreknowledge, we can apply learnings and best practice within the regulatory framework in a way that will save time and money in a safe manner. The geological risk can be quantified and usefully communicated with the well examiner and regulator.

Resource challenge in decommissioning

Due to the recent down turn, many G&G teams are under-staffed, and those available are typically focused on exploration and/or production in order to replenish or get the most out of their hydrocarbon portfolios. With limited resources, there is a risk that well abandonment programs are not optimised. Without explicit consideration of subsurface workflows, there is potential for unsafe plug placements and consequential environmental damage.

Independent review and due diligence

To address this resource shortage and provide confidence to operators in their well P&A designs, Ikon Science can provide independent reviews and due diligence on proposed plans.

Evaluating from a G&G perspective, Ikon will:

- Establish plug placement suitability.
- Determine if there are any gaps, e.g. low toxicity oil-based mud to be isolated from the seabed, cement bond long evaluation for annular isolation, etc.
- Identify areas where the P&A design could be more efficient.

Ikon leverages working knowledge from a database of 6,000 North Sea wells and their analysis, specifically to evaluate whether the overburden has been simplified in the context of existing regional knowledge.

Ikon's research includes:

- Reservoir overpressure maps
- End of well reports
- Composite logs
- Drilling histories
- Algorithms for formation strength

Establishing best practice

In today's climate, companies have limited resources to collect, clean, and analyse all the data they need, and the problem is further complicated if their non-operated assets are included. Companies often suffer from limited standardization where each partner, and each business unit within each partner, develops its own methodology. Projects end up being over-complex, over-engineered and time-consuming processes.

To help increase efficiencies and reduce costs in P&A standards and designs, there seems to be a significant opportunity to get the most out of the large amounts of data.

Knowledge management, data analytics and machine learning

The availability of large, publicly accessible regional well datasets (e.g. Common Data Access (CDA)) offer the opportunity to apply robust data + analytics and machine learning (ML) techniques that can add value to the current understanding of the subsurface.

Ikon Science offers a number of software solutions to address the opportunities of ML.

- Regional Pressure and Rock Property datasets – over 4,000 wells evaluated across multiple studies in order to provide regional credibility for well scale studies. Regional knowledge is readily available which can be incorporated quickly to help minimize risk. Such studies provide geological trends, comprehensive petro-physical, rock and fluid pressure databases to help identify facies and pressure connectivity and identify current reservoir and non-reservoir overpressures for isolation.
- RokDoc External interface is fast becoming the tool of choice for machine learning (ML) and artificial intelligence applications spanning the various geoscience and engineering domains critical to subsurface operations.
- Theseus Knowledge Management system is a software solution that captures, aggregates and manages company knowledge and information and provides a framework for large scale ML and AI applications.

Conclusion

Ikon Science brings together knowledge, experience and a substantial database of public and proprietary data to address the challenges posed by decommissioning, and specifically well plugging and abandonment. With a 15-year track record as a subsurface geoscience innovator, Ikon can offer unique insights and standardisation of P&A workflows to unlock value and provide confident decision-making.

References:

[1] Oil and Gas UK. (2017, November 01). Decommissioning Insight Report. Available at: URL www.oilandgasuk.co.uk

[2] Oil Voice. (2018, April 12). Preparing for the next wave of offshore decommissioning. Available at: URL www.oilvoice.com

[3] Offshore Support Journal. (2018, February 09). Without cost reduction Asia Pacific decommissioning bill could hit US $100Bn. Available at: URL www.osjonline.com

[4] Oudenot et al. (2018, April 11). Preparing for the next wave of offshore decommissioning. Available at: URL www.bcg.com

[5] Log, O. (2016). Centrica experience with cap rock barriers on Canadian land wells, Sixth Norwegian Plug and Abandonment Seminar

[6] Oil and Gas Authority (2017, June 01). UKCS Decommissioning Cost Estimate Report. Available at: URL www.ogauthority.co.uk

[7] Oil and Gas UK. (2015, July 01 Issue 5). Guidelines for the abandonment of wells. Available at: URL www.oilandgasuk.co.uk

[8] Mosely, M. (2015, April 21). Oil and Gas UK WLCPF Well Decommissioning Group update on guidelines. 5TH European SPE Seminar on Well Abandonment, Aberdeen.

Email info@ikonscience.com for a demonstration or visit ikonscience.com to discover more.

Ikon SCIENCE