

SPE review

Magazine of the Aberdeen and London sections of the Society of Petroleum Engineers

Issue 239 April 2010



Women in energy – make your ambitions a reality, see page 9

CONTENTS

Features	page
SPE Champions	02
Finding a career path	
Another Perspective update	
Breakthrough donation	03
Formation damage	04
Sand management	05
Drilling automation	06
Well integrity	07
Flow assurance: hydrates	08
London's summer ball	09
Continuing education events	10

Every issue	page
Contacts	02
Get to know	10
Consultants listing/Sponsors	11
Forthcoming events	11

The effects of complex reservoir geometries

On 27 April in London, Stuart A. Cox from Marathon Oil Company will give a presentation on the effects of complex reservoir geometries and completion practices on production analysis in tight gas reservoirs.

Production analysis is commonly performed in tight gas reservoirs because this analytical technique can be used to quantify reservoir flow capacity, gas in-place, and reservoir geometry (both area and aspect ratio). The results have been used to estimate the effective drainage area, infer completion efficiency, and evaluate infill drilling potential for tight gas reservoirs.

The question addressed in this lecture is: when performing production analysis, can complex reservoir geometries and completion practices cause linear flow, limited effective fracture half lengths, and limited drainage areas to be predicted? The short answer is "yes". Complex reservoir geometries and post production completion techniques do influence the results obtained from transient production decline analysis.

This talk will demonstrate the effects of stress-dependent permeability, radial composite reservoirs, and multi-layered reservoirs on the results obtained from production analysis. The completion issues addressed will include hydraulic fracture clean up, fracture conductivity reduction, and liquid loading.

Laboratory studies and field examples will be presented that demonstrate the effect of liquid loading on well performance and the resulting production increase after the liquid loading was eliminated. The ability to analyse the effects clearly helped to correctly evaluate well performance and implement steps to improve future well performance.

Stuart Cox is a Senior Technical Consultant with Marathon's technology services organisation in Houston, Texas. He has 23 years' experience focused on operations and reservoir engineering. Stuart has written 12 papers published by SPE on this topic.

London venue: Geological Society, Piccadilly. Pre-dinner presentation starts at 5pm, followed by a buffet supper. After-dinner presentation starts at 7.30pm.

Price: £33 for SPE/EI/PESGB members, £43 for non-members, £18 for retired and unemployed members and students go free.

Bookings: Secure advanced booking at www.katemcmillan.co.uk or email katespe@aol.com or telephone 07736 070066.

Focusing on Forties Well Integrity

Brett McIntyre, of Apache North Sea, will be guest speaker at the Aberdeen Section's monthly evening meeting, on 28 April. His presentation, Forties Well Integrity, will summarise the key issues, challenges and experiences from one of the North Sea's oldest and most significant fields. The event, at the Douglas Hotel, 6.30pm, will be followed by a networking buffet.

Aberdeen venue: Douglas Hotel, 6pm.

Price: £20 for SPE/EI/PESGB members, £25 non-members and £5 students. A supplement of £5 will apply to bookings less than 24 hours before the event.

Bookings: Secure advanced booking at www.hulse-rodger.com or telephone 01244 495051.

SPEreview

The Society of Petroleum Engineers (SPE), a not-for-profit professional association of 74,000-plus members from more than 100 countries worldwide, is a key resource for technical knowledge related to the oil and gas exploration and production industry. The SPE provides services through its global events, publications and website at www.spe.org

If you have read this issue and would like to join the SPE and receive your own copy of SPE review and many other benefits – or you know a friend or colleague who would like to join – please visit www.spe.org for an application form.

CONTACTS

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Could you be an SPE Champion?

SPE Aberdeen Membership Committee's first Champions event of the year, at Tiger Tiger, on 11 March, provided an excellent opportunity to discuss various ways to better serve the membership and also to attract members to participate in various events and programmes organised by the Section.

One of the key ways of doing this is to encourage members to become SPE Champions for their own organisations. Several Champions are already active within local companies, but there are still many organisations that could benefit from having a Champion of their own.

Based on the discussion, the Membership Committee has committed to providing existing Champions with information and materials to support their member colleagues and find out the best ways of serving the membership. It will also monitor progress to identify any significant improvement in membership participation in Aberdeen Section activities.

The Committee is also planning three lunchtime events in 'hub' locations across the city, where the majority of the members work. The events, co-organised with the Programme Committee, will help to bring those members together who cannot attend the evening meetings.

If you are interested in becoming an SPE Champion in your own organisation, please contact Aberdeen Membership Committee at Aberdeen_Membership@spe.org

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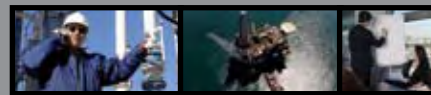
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Another Perspective shares the inside story

Aberdeenshire secondary school student Lauren Gale received a fascinating insight into BP's onshore and offshore operations after Another Perspective arranged a surprise guided tour of the operator's Aberdeen HQ.

Lauren, from Westhill Academy, was invited to find out first-hand about the industry after showing a keen interest in the work of Another Perspective in attracting female talent to the oil and gas sector.

She and her teacher, Hilary Young, were greeted at BP by AP Committee member Leigh-Ann Russell (BP Completions Engineering Manager) and Mark Smith (BP Drilling Engineering). The tour began with lunch in the BP restaurant and was followed by a brief visit to each department, including a session in the recently-upgraded drilling ACE (Advanced Collaborative Environment) facility, which demonstrated real-time operations on BP offshore installations.

The experience concluded with a question and answer session, and Lauren was presented with an SPE gift voucher by Leigh-Ann, in recognition of some excellent artwork she had created to help raise awareness of Another Perspective.

Full of energy and ideas? You should join the Another Perspective Committee.

Another Perspective is an SPE Aberdeen Section initiative to encourage female talent to enter the energy industry and to provide mentoring and networking opportunities for those already working in the energy sector. The Committee is currently looking to recruit new members. If you are interested, please contact AP Chairs, Stephanie Nwoko and Maria Trujillo, Senergy, at: Another_perspective@spemail.org



SPE Aberdeen supports breakthrough research

Continuing our series on SPE Aberdeen's charitable donations as a result of last year's highly-successful programme of Continuing Education events, sponsor Diane Wood explains how SPE funding will help Breakthrough Breast Cancer achieve its life-saving goals.



The Breakthrough Breast Cancer Research Unit, at the University of Edinburgh, was officially opened in June, 2008, by HRH The Prince of Wales. Led by its directors, Professors David Harrison and Mike Dixon, the facility at the Western General Hospital is the only one of its kind in Scotland.

The Breakthrough Research Unit will use the SPE Aberdeen charity donation to help fund research for women and men diagnosed with breast cancer.

The Unit reports some encouraging recent developments. For example, in July 2009, it published in the journal *Cancer Research* results of work that has taken a significant step towards personalising cancer treatment by developing a new method to predict a patient's response to the drug Herceptin. The group is the first in the world to use computer modelling to predict individual responses to cancer treatment.

The Unit, equipped with some of the world's most advanced medical research technology, builds on the success of the charity's research centre in London, itself a leading force in breast cancer research. Across the two centres, scientists work in close collaboration, sharing specialist knowledge to make research into breast cancer research really count.

Breakthrough Breast Cancer told us: "Thank you so much for your donation and support – your help enables us to continue our work in Scotland, where we'll be working to develop the discoveries made in the first year of the Unit to their full potential and ultimately looking forward to a future where breast cancer has been eradicated. This is not just a dream; with your support we can make it a reality."

Careers in energy events

SPE Aberdeen Section and the Centre for Energy, Petroleum and Mineral Law and Policy (CEPMLP) of the University of Dundee are planning to host two careers in energy discussions, one in late April and another in late May, to promote and discuss careers in the energy sector. Student members of the SPE from all Scottish universities will be invited to attend.

The evening events will take place on the Dundee campus and will consist of a discussion with a panel of industry professionals, both experienced and new to this sector, who will talk briefly about their own careers and then take part in a question and answer session with the participating students. Questions can be both pre-submitted and texted during the session.

Each event will be followed by a networking reception.

For more information, visit: www.spe-uk.org

Technical or managerial?

Aberdeen Young Professionals will be exploring the pros and cons of two very different career paths at what promises to be a lively meeting, later this month.

Recent SPE YP surveys have shown that approximately two-thirds of respondents aim to pursue a managerial career over a technical career. They can see those on the managerial career ladder receiving recognition and financial incentives, and perceive the achievement of a senior management position as a 'career success'.

However, is this consistent with reality? What are the trade-offs of being a manager? What benefits can a purely technical career offer? Some of the key points up for discussion at the meeting include:

- Do YPs view a technical career as less attractive and fulfilling?
- Who has more influence in corporate decisions?
- How easy it is to be able to move between roles?
- Is higher education a pre-requisite for a managerial job?
- Which career offers a better work/life balance?
- Which offers better job satisfaction?

The meeting will be fair and unbiased and will include presentations from two industry leaders and a facilitated discussion. Active participation from the audience is expected! Look out for further details of the event, date and venue at www.spe-uk.org

Formation damage 'any time, any place, anywhere'

Any time, any place, anywhere: there's a wonderful world we can share...

Remember the jingle from a certain UK TV vermouth advert from the seventies?

At the SPE London evening presentation in February, SPE Distinguished Lecturer Mike Byrne added 'any how' to the mix, settled for a glass of water, and shared his insights into the – if not 'wonderful' – certainly fascinating world of formation damage.

Mike's assertion that formation damage can apply 'any time, any place, anywhere and any how' is supported by 18 years' experience in evaluating formation damage and sand control problems – and by his numerous technical papers on drilling and completion-related formation damage mechanisms and laboratory testing good practice. Mike joined Aberdeen-headquartered diversified energy services company Senergy as Principal Formation Damage Consultant, in 2007. After several months on the global circuit of the 2009-10 SPE Distinguished Lecture Programme, he has quite literally 'any time, any place and anywhere' argued the case for a deeper understanding of formation damage.

His lecture aimed to demystify many of the legends of formation damage and their evaluation; to highlight key areas of innovation and development, and to give even the most experienced professionals present something to think about.

He defined formation damage as: "Any reduction in near wellbore permeability which is the result of 'stuff we do', such as drilling, completion, production, injection, attempted stimulation or any other well intervention. Formation damage is not a natural process."

Mike has calculated that the current best estimate of the cost of damage due to deferred production and dealing with damage is around \$100 billion per year. Based on his knowledge of the number of projects and professionals focusing full-time on the issue, he estimates that the amount spent by the oil and gas industry on understanding and avoiding formation damage amounts only to \$100m, or 0.1% of the cost.

"That gap is not a problem, but an opportunity. The big prize is not something we have to go re-exploring for – we just need to understand and avoid formation damage."

Any time

Mike's damage risk assessment ranking system (figure 1), ranks each stage during a well's lifecycle in terms of how easy it is to bypass or remove the damage that can occur. Contrary to common belief, the risks from damage are less serious at the drilling stage than at the completion or attempted stimulation stages, due to there being more options during drilling for bypassing or removing the damage, depending on the design and construction of the well.

"When I first presented this to some drilling colleagues there was a party in the room. For years they'd been blamed for formation damage and now it wasn't important. But that wasn't my point! Formation damage during drilling is important, but it's not the only time at which damage occurs. We need to consider the full well construction picture and make sure that for each stage of the process, from drilling to injection, we understand the potential damage that can occur and mitigate against it."

Mike then discussed the different types of formation damage that can occur during drilling, completion and attempted stimulation. These are summarised in figure 2.

Any place

Formation damage is equally important in exploration, appraisal and development wells, he suggested. Much focus is given to not damaging development wells – where there is already good knowledge of the reservoir – but not enough importance is placed on ensuring no damage occurs in exploration and appraisal wells. Not damaging them would significantly improve the interpretation of the reservoir data and while this is difficult in an unexplored reservoir, there is still much that can be done to mitigate against damage. What's more, there is also scope for re-examining old exploration and appraisal wells that may have been damaged and as a result yielded misleading information about reservoirs. One example is the Breagh Field, in the UK Southern North Sea, where damage to the initial exploration wells led to the reservoir being left

dormant for around 20 years. Thanks to recent work in establishing what the damage was and how it could be avoided in future wells – and then in drilling those wells and obtaining well test data – the Breagh discovery is now in development planning and is forecast to be a significant commercial success.

"There are many such examples and still more future opportunities. It's an area where simply understanding the damage can unblock the significant potential of these reservoirs."

Anywhere

Formation damage can occur anywhere, including: in the completion; in sandscreens and gravel packs; at the mud cake; near the wellbore, perhaps just a couple of millimetres into the reservoir; a little deeper than that, or very deep. The different damage depths have different impacts on well productivity and it is therefore important to understand what the damage mechanism is, its impact and its depth.

Recent work has refined inflow modelling in the near wellbore to further that understanding, and Mike discussed some examples of the advanced computer technology used.

Any how

He then considered several different damage mechanisms in detail, explaining that these were only some of the 'scores' of mechanisms that can exist in different types of wells and operations. Mud cake, fines and fluids retention were among those highlighted. One example of the potential impact of fluids retention on well productivity can be seen in figure 3, which describes a laboratory test. The slide features 'before' and 'after' photographs taken inside a single pore of a high permeability gas reservoir in the Southern North Sea. The test, which simulated drilling activity in the sandstone reservoir, demonstrated that mud filtrate retention caused a 90% loss in permeability to gas.

In conclusion, Mike said: "I hope I have persuaded you that formation damage – or at least the potential for formation damage – is everywhere and that there are real gains to be had from understanding it."

Younger members of the audience may not have recognised the reference to the vermouth ad, and while Mike was not greeted with a single olive-trimmed cocktail on the podium at any of the 31 venues on his global tour, the effervescent content of his lecture – and the potential prizes for the oil and gas industry worldwide – is sure to have left more than a few SPE members positively shaken and stirred.

Figure 2

Drilling Formation Damage

- **Mud cake- thickness/permeability**
- **Solids Invasion - shallow (surface pores only?)**
 - solids size and concentration – pore throat size distribution (not pore size distribution)
- **Filtrate Invasion**
 - clay swelling
 - fluid retention – water block
 - emulsion and sub-micron emulsion
 - scale
 - fines migration

- completion fluid filtration
- LCM and kill fluids
- **Filtrate Invasion**
 - is it bypassed by perforation
 - compatibility with other fluids
 - cement filtrate
 - mechanisms
 - clay swelling
 - fluid retention – water block
 - emulsion and sub-micron emulsion
 - scale
 - fines migration

Completion Formation Damage

- **Cased and Perforation Specific**
 - mechanical damage
 - charge debris
 - cement and spacers
- **Solids Invasion**
 - mud or other solids

Damage During Attempted Stimulation

- **iron dissolution and precipitation**
- **fines migration**
- **asphaltene deposition**
- **fracture fluid damage**
- **formation failure**
- **sludge**

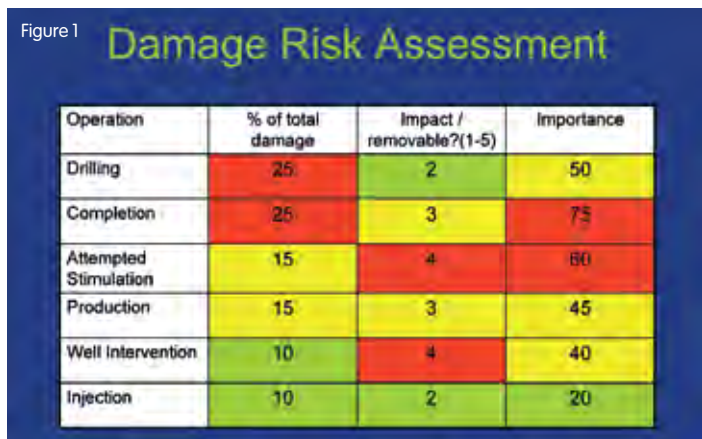
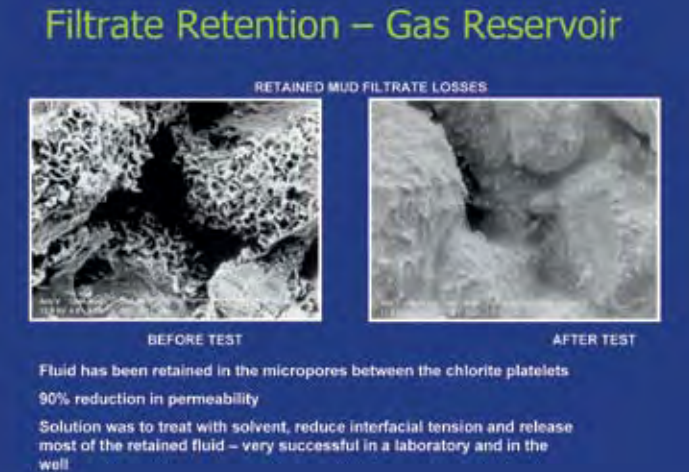


Figure 3



Controlling sand's in everyone's hands

Lively discussion and new learnings were key features of this year's European Sand Management Forum, at AEEC, in March.

Now in its fourth year, the biennial specialist SPE-Sand Management Network event was well-attended by oil and gas industry professionals keen to improve their understanding of sand production issues and the range of technologies and techniques available to tackle them.

"Our event attracted a good turnout of more than 150 international delegates who enjoyed two full days of presentations and case studies," says Committee Chair Professor Babs Oyenyin, of The Robert Gordon University. "We were also pleased to host a large exhibition of service providers and a fully subscribed pre-conference workshop."

The conference was launched by two keynote addresses. Thorvald Jakobsen, Vice President Production Technology, Statoil, presented an operator's view of the coming challenges in sand management and advocated a multi-disciplinary approach to the issue. Matthew Kebodeaux, Completions Systems Product Line Vice President, Baker Hughes, gave an insight into the future of sand control technology, highlighting OPEX-reducing systems such as slurry-less sand control and steerable, drill-in sand control liners.

A range of high-quality presentations and case studies followed over the two days, grouped under the themes: sand prediction; sand monitoring, formation damage and management; unconventional reservoir management; topsides, asset management and integrity, and sand control.

Participants also enjoyed a number of networking and 'browsing' opportunities in the exhibition area, where representatives from a number of service companies shared some of the innovative sand management solutions available today.

Exhibitor Yofri Yasar, from Roxar Flow Measurement, a division of Emerson Process Management, commented: "We're promoting our range of sand monitoring and management equipment and there's been a lot of general interest from the operators. Many people are aware of our individual products, and this event has given us an opportunity to explain how these products can work together to provide an integrated solution. It's my first visit to the European Sand Management Forum

and I can see there's a lot of good work being done and innovative approaches being discussed. However, it would be good to hear more about the connection between sand management strategy and the equipment and service-based solutions available to work towards a more standardised approach to the issues involved."

Delegate Sunil Kumar, Production Technologist from BG Group, said: "It's been a very informative event. Sand management is part of my day-to-day work and it's been interesting to see some of the new technology around. I'll be going back to my team with some good ideas and learnings. I think the most important message from the conference is the need for integration and communication between all the different departments – from subsurface to topsides and operations – in order to manage sand issues more effectively. This is something the industry, generally, needs to take on board."

The next European Sand Management Forum will be held in March 2012.



L-R: Thorvald Jakobsen, Vice President Production Technology, Statoil; Professor Babs Oyenyin, The Robert Gordon University, Chairman of Sand Forum Committee; Matthew Kebodeaux, Completion Systems Product Line Vice President, Baker Hughes.

Regional Focus: The former Soviet Union

Thursday
29 April 2010
9.30am to 5.30pm
Geological Society
Piccadilly, W1



Dave Connell
Chevron (Previously Site Manager
Tengiz Second Generation Project)
Tengiz Second Generation and Sour
Gas Injection Projects

Harry Verkuil
Chief Operating Officer,
Regal Petroleum plc
The successes and challenges
of operating in Ukraine

Ian Thom
Caspian Lead Analyst,
Wood Mackenzie
Overview of reserves, production and
value of upstream positions held by
company grouping (NOCs, Majors,
independents etc) and country

Dr. Theodor Felder
Regional Manager CIS,
IHS Energy Russia
Recent E&P Trends

Paul McMoran
HR Director, TNK-BP
Developing Russia's Petroleum
Professionals.

Luís Coimbra
Chevron, General Manager,
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Jim Gillett
Business Development Manager,
Gaffney Cline & Associates
Emerging markets: Turkmenistan:
a significant gas producer for the future?

Bob Stephens
(Previously Reservoir and Petroleum
Engineering Manager) KPO
Technical challenges of operating
the Karachaganak field

Weatherford
The hurdles of operating in the FSU,
notably Russia, and the differences
between Eastern and Western
technologies

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Exploring the emotive subject of drilling automation



Automation is an emotive subject. From its earliest days, science fiction has understood and played upon our natural fear and distrust of 'sentient' machines. Walt Aldred, Research Director Drilling at Schlumberger Cambridge Research Centre, and representing SPE DSATS (Drilling Systems Automation Technical Section) as guest speaker at the Aberdeen Section's February meeting, argued that such emotions are still with us – and can be triggered at the click of a laptop mouse.

Walt's presentation, Levels of Drilling Automation, aimed to dispel some of the confusion and distrust that has arisen in the oil and gas industry around the current

and future use of automatic drilling systems. The fact that drilling automation means very different things to different sectors of the industry has been blamed for slowing progress in the area and DSATS was formed to help address some of these issues. The fundamental principle of DSATS is to view drilling as a system, rather than as a series of individual components. Wearing his DSATS hat, Walt promised to share some of the organisation's learnings from other industries and its work in developing a common view of the process within our own.

He first made it clear what he was not going to discuss: "Iron roughnecks and racking systems are mechanisation, not automation; drilling screens are information, although information is an important part of automation. And remote operations can be enabled by automation but are not the main purpose of automation. The main purpose is really optimisation," he explained.

He then turned to today's drilling systems (see figure 1) which are controlled by both drilling contractor at surface and the direction drill downhole. "Anyone who knows anything about control systems knows that a system with two controllers is not ideal." The future scenario described, he argued, would create a more co-ordinated system that would increase efficiency, our capabilities, and better respond to well complexity: "In ever more complex situations, we need our machines to help us reach our target."

Walt then discussed a number of scenarios in which automated drilling had dramatically improved performance. One example showed a doubling of the reliability (mean feet to failure) of downhole tools on first and second generation of automated land rigs developed by one drilling contractor, and a trebling on their third generation automated rigs when compared with a good comparable quality conventional manually operated land rigs in the US. The difference between the second and third generation, he explained, was the degree to which the individual components – top drive, pumps and draw works, eg – were integrated into a single system. "These are some of the reasons we should be thinking about automation," he concluded.

The 'emotional' part of the talk came when Walt challenged the audience's perceptions by suggesting that industrial robots tend to make people think of factory redundancies, and that android-type figures usually bring to mind all kinds of science fiction scenarios – most of them negative!

What many people don't realise, he said, is that there are several different levels of automation and that as part of its research DSATS had identified nine in all. "Automation is not a one-size-fits-all process; there are lots of variations," he explained. Walt again tested the audience's reaction by asking how many felt

comfortable with each level, and was not surprised to see that the numbers of hands diminished as he went up the scale towards more autonomy. One audience member was very comfortable with level 8 ('decides everything and acts autonomously'): "That's my dishwasher," was his cheerful response.

Turning to DSATS' learnings from other industries, Walt discussed several examples of automated systems, including the rapid development of autonomous vehicles in response to the annual US DARPA Grand Challenge; the SAS Green Approach to landing aircraft in a more energy-efficient way using onboard automation to improve performance; and a 'coming soon' multi-flight optimisation process in which an air traffic control system 'talks' directly to the aircraft autopilots. To anyone shifting in their seat at the thought of pilotless planes, Walt said: "How many computers have problems with alcohol or haven't slept enough hours before taking control of a plane? Humans are not infallible! Adopting such systems will not get rid of the pilots, but instead will give them appropriate jobs and the tools to achieve significant improvements in performance."

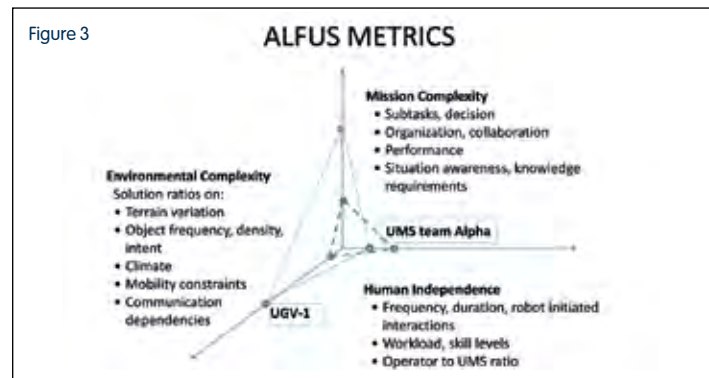
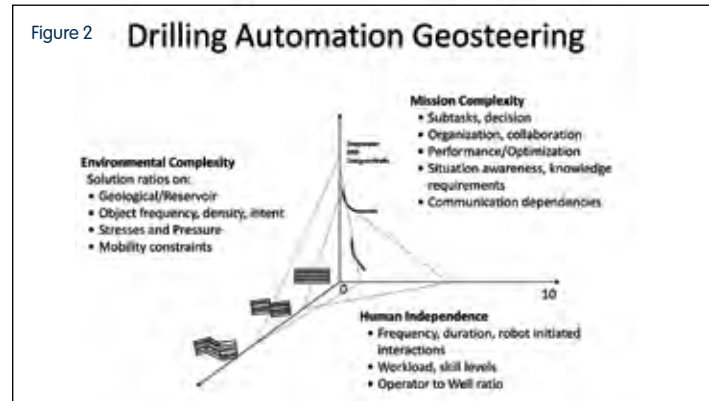
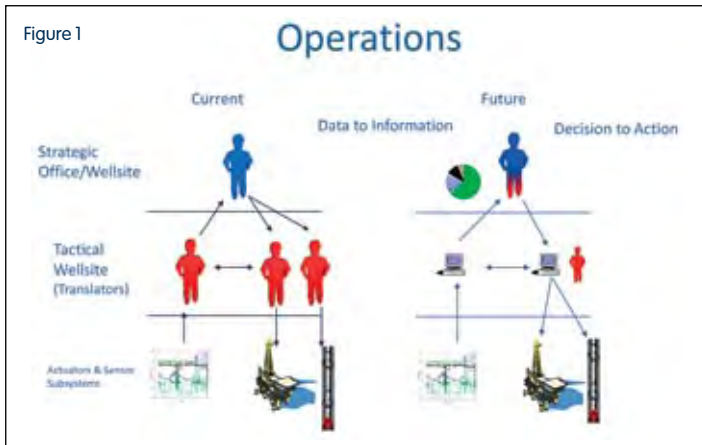
Returning to drilling automation, Walt said there is much to be learned from the use by those developing autonomous vehicles of Alfus Metrics, and he showed how the methodology could be applied to drilling automation geosteering (figures 2&3). He suggested that there is no shortage of sophisticated systems; the problem is getting them to 'shake hands' with each other and perform as an integrated whole. DSATS believes that careful selection of different levels of automation is critical, as is the design of each level of automation as a man-machine system.

"We have established, then, that the technology does exist to implement many levels of automation, but quality improvements are required in terms of software and surface and downhole sensors," he said. He also acknowledged that business and system integration remain a major barrier to progress.

However in shedding light on the issues, practices, learnings and future developments of automated systems in general, SPE DSATS is helping to dispel the old myths and prejudices, and is establishing a common understanding within the oil and gas operator and services community of the true potential for drilling automation going forward.

Walt concluded his entertaining presentation by highlighting two major drilling automation events this year:

- ATW Drilling Automation, Galveston, Texas – 13-14 April
- Forum: The Automated Well Construction Factory, Paris – 10-15 October.



Well integrity – warts and all

With a 'just for fun' electronic audience poll providing a lively launch to proceedings, SPE Aberdeen's panel discussion on North Sea Well Integrity Challenges provided an engaging forum for some frank discussion about one of the oil and gas industry's most controversial issues.

The poll gauged that those attending the TecWel-sponsored evening meeting, in November, were a mixed audience, ranging from students to experienced 'old hands' with differing levels of knowledge and expertise in well integrity matters.

The panel of industry experts, including Martin Mosley (Talisman Energy UK) and Graeme Rae (Chevron North Sea), made it clear they were expressing their own opinions, rather than representing those of their employers. They highlighted many of the concerns and issues shared by the industry and it quickly became evident from this valuable awareness-raising session, that there are many challenges to be faced as assets age. Here is a summary of some of the key points raised.

Definitions and regulations

Norwegian Standard (Norsok D010) defines well integrity as: 'the application of technical, operational and organisational solutions to reduce the risk of uncontrolled release of formation fluids through the lifetime of the well.'

This means designing and constructing wells to applicable standards; monitoring, maintaining and repairing those wells during their lifecycle, and having the relevant procedures and competent people in place to manage the overall process.

In the UK, key legislation relating to well integrity is the Design and Construction Regulations 1996 (DCR), which everyone involved in the discipline should be familiar with. The DCR and several other regulations focus on the integrity of offshore installations, including the safety of wells and the verification of all the installations' safety-critical components. DCR Part IV is specifically aimed at wells, and the significant implications of Sections 13-21 were highlighted. The operator / duty-holder is responsible for compliance with the regulations and must ensure the safe condition of wells throughout their life, from design to decommissioning. An important requirement often overlooked is that this also applies to protecting the strata outside of the well.

Industry standards, guidelines and practices usually relate to the manufacture of well equipment, rather than to the operation of the wells. The policies and procedures for the management of well integrity developed by operators tend to be specifically suited to the organisation and types of equipment for each operator. This has led to a variation in strategies, best practices and policies – ultimately begging the question: 'What is well integrity?'

Xmas trees and wellheads

"Some things to consider": Single or double slab gate valves? "Speak to the manufacturers and they'll advise single, as they're cheaper and easier to manufacture. But consider the question: what are you going to do when – not if – they fail?"

Are your wells really designed to comply with the regulations for the complete lifecycle of the well? Producer to injector? Decommissioning and beyond?

Have you considered at all potential well integrity scenarios and their likely repair options? Fish in well upstream of perforations? Leaking swab or master valves?

Are you sure you have the well barriers you think you have? Packer failures? Leaking tubing or casing strings?

Are you checking the voids, particularly on the older wells? What are the hidden weaknesses?

What does scale do to your wells in terms of compromising well integrity? Will your safety systems operate?

Good quality data is crucial to obtaining the right information, which in turn empowers decision-making. Real-time data capture together with regular expert reviews of the data, are key elements of the process.

There are some good test technologies in the market and some examples of these were discussed. However: "There needs to be a bigger industry focus on technology development for well integrity."

A number of possible 'blind spots' need to be considered by the industry:

- Conductor integrity - Who owns it?
- Corrosion engineering - Need to build competency.
- Factor in well integrity in decommissioning risk.

Responsibility extends beyond P&A. There are plenty of new opportunities for developing technology and competence, eg decommissioning, a growth industry, is dependent on a good understanding of well integrity.

Emergency systems for wells

In addition to the emergency shut-down systems of the Xmas tree and wellhead, there are a range of down-hole emergency shut-off devices, most controlled from the surface with a safety control line.

The Health & Safety Executive is currently focusing on well annulus management and down-hole safety valve integrity. Offshore operations teams are being questioned regarding their understanding of these issues, e.g. if a safety component fails, what do you do about it? Operators need to ensure they support their operations teams with the necessary training and information.

There are developments for installing actuated valves within the wellhead which will mitigate against the failure of annular safety valves. A key differentiator between UK and Norwegian legislation is that under certain circumstances, the Norwegians also consider gas lift valves as barriers. How, and how often, you verify those is an issue preventing UK operators from considering gas lift valves as downhole barriers.

Maintenance: how long is a well viable? How often should you carry out interventions? What are acceptable leak rates and do the same leak rates for downhole safety valves apply to gas lift and annular safety valves? Can you really have an allowed leak rate for an emergency device?

UK legislation does not provide technical guidance for such questions. There may be a benefit to operators and the HSE, establish an industry forum to discuss common practices. "Considering many North Sea wells are now way beyond their design lifetime, I'm amazed at how well they have lasted."

Well integrity management is also about building competency. This starts at student level. "It's encouraging to see so many students and young professionals participating in this event."

Q: How do you know if you have compromised integrity in a subsea well?

A: There are a lot of subsea wells out there whose annulus pressures cannot be monitored. There's one way of finding out and it's expensive – subsea intervention. A case for this has to be made to management and it's very difficult to ask for money when you don't know if you have a problem or not! You need data to remove the speculation – and obtaining good data is a challenge.

Q: What will our great-grandchildren be saying about the longevity of North Sea wells?

A: The decommissioning issue is something we are facing now and will be facing a lot more in the near future. Decommissioning is permanent – but how long is permanent? It's a question the industry is only just starting to tackle. The Design & Construction Regulations talk about the lifetime of the well – and that goes beyond decommissioning.

Well Integrity: The Process

Data

- What do you need to gather?
- Who gathers it?
- How is it gathered?



Information

- How accurate is your data?
- How is the data stored, distributed and accessed?
- Can you make a decision?



Action

- Long or short term solution?
- Do you have access to the right technology?
- What does the history book tell you?



Prioritization

- What are the critical issues?
- Which issues can you resolve?
- Which issues can be deferred?

Implementation of Well Integrity

Key area of well integrity:

- Trees and wellheads
 - Connect production facilities to well/reservoir
- Annuli
 - Isolation of reservoir/production and stability of wellbore
- Emergency systems
 - Safety critical and fail-safe systems



Flow Assurance 101: Hydrates

By Temitope Solanke, Sung-Oh Yang (PhD)
Multiphase Solutions Ltd UK.

It is yet another quarter from the last edition of Flow Assurance 101. As was mentioned in the last edition of the series, deepwater developments tend to be characterised by high expenditure and a number of flow assurance challenges. Because of the high expenditure, the cost of failure is dire, hence the importance of flow assurance in managing the challenges associated with production chemistry and multiphase flow.

Hydrates are ice-like crystalline compounds consisting of water and suitably sized gas molecules. Hydrogen bonding of water molecules leads to the formation of lattice structures with several cavities that guest molecules can occupy. These lattice structures become stable when a minimum number of cavities are filled, resulting in the formation of solid gas hydrates. Hydrate formation can be expected at low temperatures around the ice point and high pressures [see figure 1]. These high pressures and low temperatures are conditions common to deepwater oil and gas developments that provide ideal conditions for the formation of hydrates. Hydrate formation occurs most frequently during shut-in and start-up as the line is usually at its lowest temperature.

Hydrate formation can be prevented by (1) water removal, (2) increasing temperature or decreasing pressure and (3) adding hydrate inhibitors. The permanent solution is the removal of water prior to pipeline transportation. As easy as this might sound, the major constraint for this method in today's deepwater development is cost, as it would require offshore dehydration plants or subsea separation. Avoiding hydrates relies on the idea of preventing the hydrate envelope and P-T production facilities from intersecting during normal production. This can be achieved by moving the hydrate envelope to the left by injecting thermodynamic inhibitors, or shrinking the P-T production facilities profile to the right by increasing insulation level or applying direct electrical heating (DEH). While DEH is a tested and proven method, its feasibility is questioned for very long distances due to the high cost associated and topside capabilities of host platforms. Lowering pressure by the depressurisation process is the other way to avoid hydrate formation.

Hydrate inhibitors are divided into three subgroups: thermodynamic inhibitors (THI), kinetic inhibitors (KHI) and anti-agglomerates (AA). Thermodynamic inhibitors such as alcohols and glycols are hydrogen-bonding components and hinder hydrogen-bonding cage formation. Hence thermodynamic equilibrium line is shifted to the left. The amount of required THI is determined by the thermodynamic driving forces for hydrate formation and the amount of produced water. The cost of THI increases dramatically if water production is significant. Methanol and MEG (monoethylene glycol) are the most common THIs and both have their advantages depending on the system they are used in. While THI is time-independent and permanently prevents hydrate formation, KHI limits hydrate growth within a hold time. KHI adsorbs at the kinks of hydrate crystals, which prevents adsorption of more gas components, thereby suppressing nucleation and growth of hydrate crystals. AA acts on the surface of hydrate particles and reduces the attractive force between hydrate

particles. Hydrates will form but will not make hydrate plugs in the presence of AA. KHI and AA are referred as low-dosage hydrate inhibitors (LDHI) due to the low amounts required compared to THI.

Even with prevention methods, hydrates can be formed during unplanned shutdown and restart, and malfunction of dehydration units. Figure 2 shows hydrate plugs after pigging. Hydrate formation as a result of the Joule-Thomson cooling effect across chokes is not uncommon during the restart process. Once a hydrate plug is formed in the flowline, it has to be removed to regain the flow. The most common hydrate remediation method is depressurisation. This process poses a safety concern, especially during the single-side depressurisation, and the feasibility of the operation is dependent on constraints such as time, cost and safety.

SE Tahoe, operated by Shell, experienced under-inhibited hydrate formation due to dramatic increase of water production in later field life. By allowing hydrate formation for two weeks and injecting methanol to dissolve hydrates, the field life was extended more than two years. It can be seen in Figure 3 that the salt content of water affects the position of the hydrate curve.

Recent research on the topic of hydrates ranges from kinetic modelling to new cold flow technology. Hydrate kinetic models are incorporated into flow simulators to predict location and time of hydrate plug formation. Hydrate kinetics can provide risk management, while hydrate thermodynamics can provide avoidance techniques. Cold flow technology led by SINTEF aims to make non-sticky hydrates, which flow down but do not agglomerate and make plugs. Non-sticky hydrates can be made by various methods, such as hydrate seeding, rapid hydrate formation with excessive driving force and use of AA.



Figure 2: Hydrate plug after pigging, Campos Basin, Brazil
(Picture taken from SPE JPT Online Magazine, Vol. 59 No. 6, 2007)

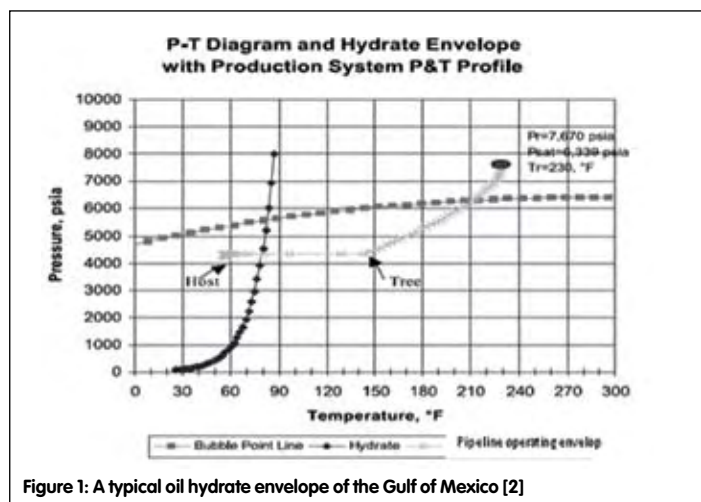


Figure 1: A typical oil hydrate envelope of the Gulf of Mexico [2]

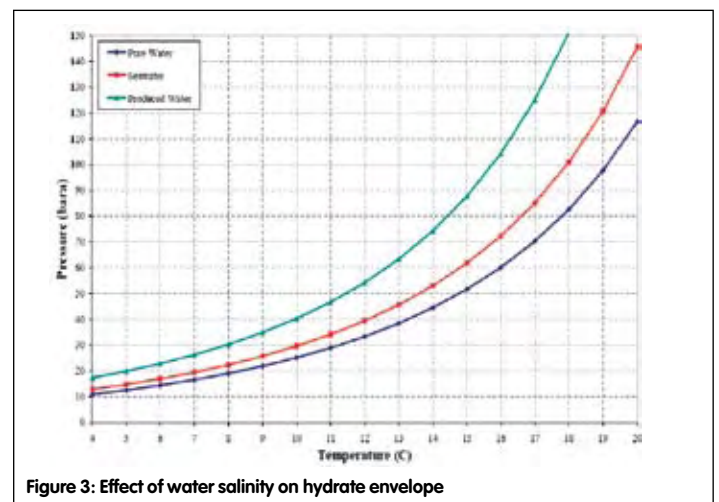


Figure 3: Effect of water salinity on hydrate envelope

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SPE LONDON SECTION PRESENTS

WOMEN IN ENERGY

The Next Step – Make Your Ambitions a Reality

Thursday 13th May 2010, 9.00am to 5.00pm

Geological Society, Piccadilly, London, W1

- Do you know where you want to end up but have no idea how to get there?
- Do you feel success is not all about work?
- Are you interested in the differences between being assertive and aggressive?
- Do you ever wonder how to negotiate effectively?

If you have answered 'YES' to any of the above then this day is for you!

This one-day seminar is designed to help address some of the key challenges women face in their professional lives in the oil and gas industry, giving you the time and space away from your hectic work life to consider and work on your personal and career development. The day will include experiences and advice from senior women in the petroleum industry:

- **Maria McCaffery**, Chief Executive, RenewableUK (formerly BWEA)
- **Sally Martin**, Consultancy Manager, Shell Downstream Management Consultancy President, Shell Women's Network
- **Joan MacNaughton**, Senior Vice-President, Alstom
- **Rhonda Morris**, General Manager Marketing, Chevron

You will have the opportunity to work on various aspects of your personal and career development in our expert-led mini workshops focusing on issues such as:

- **Assertive not aggressive** • **Negotiation skills** • **How to fast-track your career**
- **Your own personal brand** • **The importance of finding the right mentor**

A more detailed agenda can be found at www.spe-uk.org, London Section Events.

TICKETS: £35 (includes VAT and lunch). Informal drinks after 5pm.
BOOKING: Secure advanced booking at www.katemcmillan.co.uk or contact Kate McMillan on 07736 070066 or email katespe@aol.com

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London Section

GET TO KNOW

Brian Moffat, Director, Petrophase Ltd

How did you come to join the industry? By accident! I answered an advertisement in New Scientist magazine to help build a PVT lab. I didn't know what one of those was at the time.

In hindsight, what other industry (if any) might have suited you?

I often wonder what would have happened had I stayed in the chemical industry. Most of my fellow chemists went straight into accountancy after graduating; I knew I didn't want to do that.

What was your first job?

An industrial organic research chemist for Courtaulds. The job ranged from pushing curly arrows round organic molecular structures on paper, through developing pilot plant operations and sometimes inadvertently blowing things up!

Where do you call home?

South East England, though exactly where has become vague after several moves.

What's your philosophy of life?

To be optimistic and creative.

What's your proudest moment?

On an emotional scale nothing can surpass the birth of a child. On the technical front I have had several world firsts each of which was a proudest moment at the time, the last was working out the mechanism behind lateral concentration gradients in the Buzzard field [SPE 123875]

What do you think is the most urgent issue facing the petroleum industry today?

I think there are two – gaining and retaining enough engineers into an industry which does not have a good image with the public, and secondly, reconciling production levels with reduced carbon economy.

What do you still want to achieve in your career?

Having set up my own company Petrophase five years ago to specialise in Petroleum Fluids, I would love to see this continue to grow and develop.

What does your SPE membership mean to you?

It has given me opportunities to publish papers, present at meetings and since working independently, it's been very useful for networking.

Favourite book / music / film or gadget?

Gadgets are fine till they stop working and you realise how much you rely on them and how much information can be lost. So I'm more in favour of music at the moment: favourite pieces would include Hendrix's The Red House (live version) for its fire and Schubert's piano sonatas for their soul.

What do you like most about the industry – and what do you like least?

I have met some wonderful and creative people in the industry and I'm constantly impressed by the level of professionalism. On the downside I see the same wheel being reinvented time after time.

What was your last holiday destination?

It was a few days on the East Sussex coast, very little travelling and no airport hold-ups!

What would be your perfect day?

I did have a perfect day once, a scramble along the Cuillin ridges on Skye with good friends. It felt like being on top of the world. The sun shone and was midge-free, most remarkable!

If you could have a one-to-one with a famous historical figure, who would it be?

I would love to meet Sigmund Freud and find out how he drew his insights into the human condition.

Forthcoming Aberdeen continuing education events

DEVEX 2010

12-13 May

Aberdeen Exhibition & Conference Centre

DEVEX, now in its seventh year, is a world-class centre of subsurface production techniques and expertise. This year's event: Recovery: Everyone Plays a Part, will feature a varied programme of insightful presentations accompanied by a lively exhibition showcasing the latest technology developments in the field.

In a new approach this year DEVEX welcomes two keynote speakers representing both the Service and Operator sides of the business. Olivier Le Peuch, VP and General Manager for Schlumberger Oilfield Services, North Sea, and Eelco von Meyenfeldt, Developments Manager for Shell Europe, will share a platform and their perspectives with the DEVEX audience at the opening session.

Building on the success of last year's inaugural Pre-Conference courses, on the Tuesday immediately preceding the Conference, DEVEX is pleased to be able to offer courses on Geomechanics and Integrated Asset Modelling. The latter, in particular, offers a valuable opportunity for Subsurface and Topsides staff to gain insights into each other's constraints and opportunities when developing new resources across ageing infrastructure.

DEVEX 2010 Chairman, Graham Davis, of CNR International, comments: "Our theme stresses the importance of integrated workflows, not only in maximising the recovery from our reservoirs, but also in optimising the process for the emerging business environment. The programme, with its short two-paper sessions, has been designed to deliver a valuable mix of case histories and more specialised subjects, and I would also really encourage participants to sample presentations outwith their normal discipline 'silo'."

Graham adds: "What really differentiates DEVEX from other conferences is that, in the words of a previous keynote speaker, it is a 'conference by the people for the people!'. In supporting this event you are supporting your colleagues, your customers and your employees – we look forward to welcoming you all and making DEVEX 2010 the strongest yet.

For more information, please visit: www.devex-conference.org

SPE ICoTA European Well Intervention Round Table

17-18 November 2010

Aberdeen Exhibition & Conference Centre

The organising Committee, chaired by Callum Munro, of BP, will soon be seeking 200-word abstracts for presentations at this popular annual event in the oil and gas industry calendar, and this year aims to encourage an even greater participation from across Europe. Exhibition spaces are available now – early bookings are advised! Please contact jane.mcclure@hulse-rodger.com



Trying to tip directors Mike Fawcett (L to R) and Brian Moffatt into the fishpond are Anna Bruzco (Pet Engr), Tracey Songer (Admin) and Jaimar Maurera (Consultant Pet Engr).

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FORTHCOMING UK EVENTS

LONDON

- 27 Apr 10** **After dinner: Effects of complex reservoir geometries and completion practices on production analysis in tight gas reservoirs** *Stuart Cox, Marathon Oil Company and SPE Distinguished Lecturer*
Before dinner: Reservoir characterisation for simulation using core, lab, test and PVT data *Brian Moffatt, Director, Petrophase Ltd*
- 25 May 10** **After dinner: Don Field: A fast-track marginal field development** *Petrofac*
Before dinner: SPE Young Professionals technical showcase: A presentation of 2-3 technical papers
Chaired by Mo Mansoori of Nexen and Arnaud Mille of Centrica

CONTINUING EDUCATION EVENTS

- 29 Apr** **Regional focus: The former Soviet Union**
13 May **Annual seminar for women in the energy industry**
20 May **Joint SPE and Geological Society seminar on the northern North Sea**

VENUE DETAILS The Geological Society, Piccadilly, London W1
5pm start

ABERDEEN

- 07 Apr 10** **SPE Another Perspective technical presentation: The role of coupled geomechanics – fluid flow reservoir modelling for water injection performance prediction** *Maria A. Jimenez, Production Technologist, Senergy Ltd*
- 28 April 10** **Forties well integrity** *Brett McIntyre, Apache North Sea*
- 26 May 10** **Ways to successfully reduce well blowouts** *Brett Otto Alcantara, Petrobras and SPE Distinguished Lecturer*

VENUE DETAILS The Douglas Hotel, Aberdeen AB11 5EL.
6pm for 6.30pm start.

- 26-28 Apr 10** **SPE applied technology workshop – optimised field development planning through improved reservoir and facility engineering integration.**

VENUE DETAILS Hilton Aberdeen Treetops
Registration and info: www.spe.org/events/10aabe/

CONFERENCES/EXHIBITIONS

- 12 & 13 May** **DEVEX 2010 7th European Production and Development Conference and Exhibition**

VENUE DETAILS Aberdeen Exhibition & Conference Centre

EDINBURGH

- May 10** **Production optimisation: how can we get the oil we should be getting?**
Sandy Williams, ALP Limited

VENUE DETAILS Edinburgh University

FOR DETAILS OF ALL UK SPE EVENTS, PLEASE VISIT WWW.SPE-UK.ORG

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