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# Saudi Arabia oil & gas

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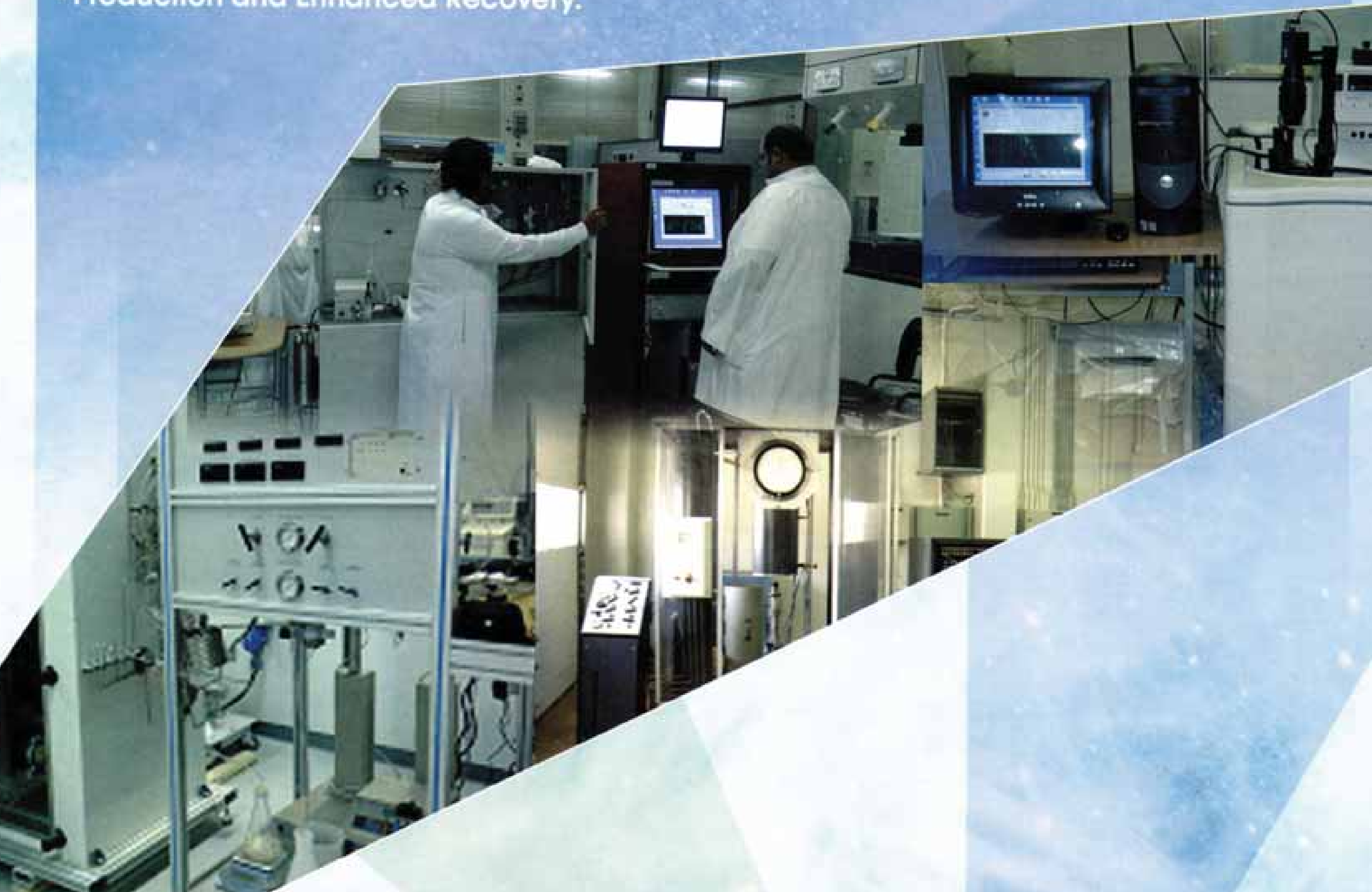
# Oil and Gas Research Institute

Hydrocarbon resources (crude oil and gas) are the main source of world energy, and as the international demand increases, the technical challenges increase to meet that demand. Hydrocarbon production optimization at minimum cost and the need to serve the national petroleum industry has been the driving force behind the establishment of the Oil and Gas Research Institute ( OGRI ) at King Abdulaziz City for Science and Technology (KACST). OGRI is a governmental research and development entity. Its applied research activities concentrate on the upstream sector of the petroleum industry. Fields of interest cover most of the petroleum science and engineering aspects through four main divisions:

- Reservoir Characterization and Numerical Simulation,
- Drilling Engineering,
- Rock Mechanics,
- Production and Enhanced Recovery.



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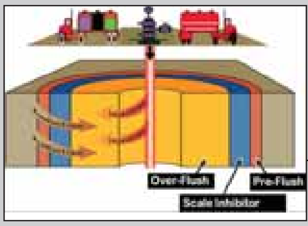





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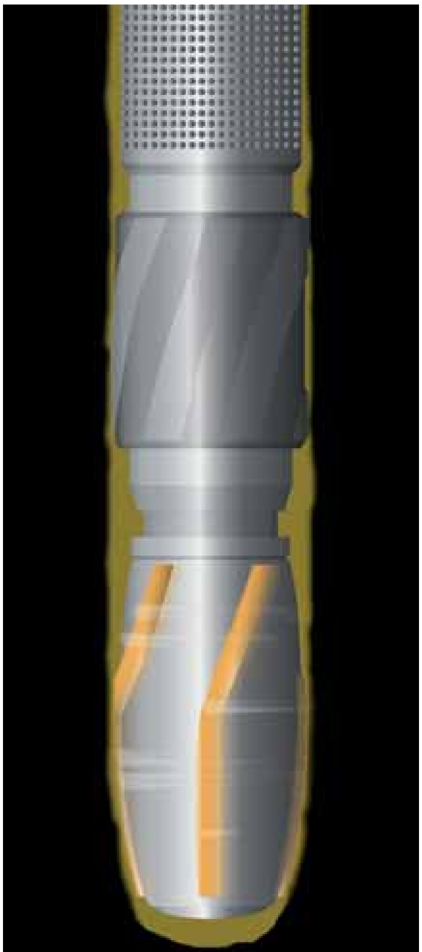
# Contents 2011 – Issue 22







# Upstream Professional Development Center Staff Acknowledged

By Khalid A. Zainalabedin, Director, Upstream Continuing Excellence.

The Upstream Professional Development Center (UPDC) team recently gathered at Salat al-Khaleej to recognize the efforts of Upstream professionals who were involved with program development, technology deployment and testing.

The four story building has state-of-the-art classrooms to foster collaborative learning along with high-tech drilling, virtual-reality and hyper-dimensional simulators that will enable young Saudi Aramco professionals to progress in their careers while working for the company.

Because of the importance of the program to the company's strategic objective, the UPDC started classes before completion of the structure, and the first class had already graduated before the completion ceremony.

"We are witnessing history in the making. This project is a solution to Saudi Aramco Upstream business needs for efficient and effective training," said Khalid A. Zainalabedin, Upstream Continuing Excellence director. "New methodologies in the training program capture senior professional knowledge and impart it to young professionals. They require different disciplines to collaborate and communicate, forcing walls to dissolve and enhancing workflows and decision making."

Upstream senior vice president Amin H. Nasser pointed out that the dedicated UPDC staff has ensured that the facility will provide an innovative learning environment for all Saudi Aramco's Upstream professionals while emphasizing the development of the next generation.

Strategic training in a new facility using the latest techniques and technologies, he said, is an important key to recruiting and retaining talent in an environment of intense worldwide competition.

Nasser was visibly pleased with the UPDC achievements as he presented certificates to the leaders of the advisory, operations, technology and administrative teams responsible for getting the center up and running.

"Both the training center and the development and deployment of the program could not have been achieved without the continuous support of the Upstream line organizations and the dedicated UPDC staff. We wish to thank you all for your hard work and look forward to future success," Nasser said.

"This project is a solution to Saudi Aramco Upstream business needs for efficient and effective training."

# R&DC Forum Focuses on Innovation, New Ideas

By Saudi Aramco Staff.

More than 200 members of the Saudi Aramco technical and scientific community recently gathered for the second annual Research and Development Center (R&DC) Technical Exchange Forum under the theme "Transforming R&DC Intellectual Capital into Added Value."

Throughout the two-day event, participants shared new ideas, innovations and advancements, in seven core areas including: Future Hydrocarbon Based Fuels; Catalysis and Process Development; Biotechnology in the Oil Industry; Carbon-dioxide Capture, Utilization and Conversion; Advances in Hydrocarbons and Materials Characterization; Advances in Chemicals and Petrochemicals; and Scale and Corrosion Mitigation.

R&DC manager Omar Abdul-Hamid said, "As a research and development organization, such gatherings are undoubtedly vital to our progression and success as they provide opportunities for the exchange of ideas and learning from each other's experiences."

Abdul-Hamid highlighted three major and recent accomplishments:

• Laser Oil Fingerprinting (or DesertRay Technology). DesertRay was developed in-house as a multipurpose laser instrument that helps identify the ingredients of blended crude oils as well as blended refined products.

• Online Salt in Crude Analyzer for Gas-Oil Separation Plants (GOSP). The analyzer can perform salt-content measurement automatically in harsh operating conditions. The prototype analyzer was tested in Ain Dar GOSP-2.

• Gas Treating Membrane Technology for Natural Gas Upgrading. This economical technology unlocks the Kingdom's huge reserves of sub-quality natural gas by removing large quantities of impurities such as nitrogen, carbon dioxide and hydrogen sulfide. The pilot plant was commissioned and tested at Shedgum Gas Plant.

Science Specialist and forum chairman Tony Rizk said, "One goal of the forum was to provide important R&D opportunities to share what's new, exciting and cutting edge."

"For younger researchers, it's learning more about areas that might interest them in terms of future study for advanced degrees," he said. "For others, it's sharing what we are doing and learning from our colleagues. And for those outside R&DC, it's a chance to see how we are taming technology for their specific applications."

Atef Al-Zahrani, a Professional Development Program (PDP) engineer, found the event remarkable. "It offers me the opportunity to practice and share the knowledge we have as a team and get feedback and suggestions from attendees," he said.

First-year R&DC scientists Hassan Al-Jama and Mohammed Al-Abuallirat agreed.

"Even though I work here, I can't be aware of everything that's going on at R&D," Al-Jama said. "This event let me learn about projects and products R&DC is involved in and how they're making contributions to the company."

Al-Abuallirat liked the exposure to new ideas and activities – something he hoped would spark his interest and lead to further exploration and an advanced degree.

Keynote speakers included Ingo Pinnau of King Abdullah University of Science and Technology, Gautam Kalghatgi of Saudi Aramco R&DC, and Zain Yamani of King Fahd University of Petroleum and Minerals.

# USC Alumni of Arabia Chapter: First in the Middle East (from MEOS to MEOS)

By Karam Yateem, Organizing Core Team Committee Member, USCAA.

With more than 233,000 living alumni scattered around the world, the University of Southern California (USC) Alumni of Arabia (USCAA), is truly emerging as the newest chapter in the region.

By December 2010, local USC graduates from over four decades held their second dinner meeting in Dhahran in an effort to officially establish a USC alumni club in the region.

The initial gathering, which took place in July 2010, laid the groundwork in assembling the club with the theme: Opportunities for Continued Professional Development and Personal Growth.

Left: Generations of Saudi Aramco USC graduates pose for a memorial group picture.

Organized by Bahjat M. Zayed, Manager, Southern Area Production Engineering, Saudi Aramco and core team members (Ahmad Al-Kudmani, Aqeel A. Al-Sadah, Yasser A. Nughaimshi and Karam Al-Yateem); the event was sponsored by Mohammad Al-Shammary, President & CEO – Aramco Gulf Operations Company (AGOC) at the time and now General Manager of Industrial Security Operations in Saudi Aramco.

Having hosted dinner meetings and established a local database of alumni, a website is also under development with a biannual newsletter on the books called "From Coast to Coast." But the team is looking to the future when the chapter's activities will include knowledge sharing and dissemination, mentorship of current students, and the exchange of ideas.

The regional chapter is the 21st Alumni club globally and the first of its kind to be established in the Middle East, Africa, and India region. "Given that USC was established in 1880 makes this quite an achievement." Bahjat M. Zayed said.

The idea of creating the USCAA chapter dates back to a reunion function that USC graduates had with the Dean of Viterbi Engineering School, Prof. Yannis C. Yortsos, in 2009 during the 16th Society of Petroleum Engineers/Middle East Oil & Gas Show & Conference (2009 SPE – MEOS).

The need for such an initiative in the region was keenly felt among those wishing to support the overall advancement of USC. Hence, it was decided that the group would start with Saudi Arabia and expand thereafter.

In addition to promoting warm reunions and new connections, the purpose of the event was to discuss ideas for moving the club into a worldwide alumni network. Zayed, as the first organizing chairman, took upon himself the task of setting up the Alumni Club. Zayed, in accepting his role as chairman, said, "As a proud Trojan, I have always wanted to give back to the school. I will work with the core team to develop a charter, outline our vision, and articulate the path forward. We will incorporate all of your suggestions and comments as feasible," he said, speaking to his fellow Trojans.

In acknowledging this, the second dinner meeting for Saudi alumni addressed AGOC efforts in meeting

> With a strong tradition of integrating liberal and professional education, USC fosters a vibrant culture of public service and encourages students to cross academic as well as geographic boundaries in their pursuit of knowledge.

the increasing world hunger for energy in a keynote speech, delivered by Al-Shammary where he highlighted AGOC's history, achievements and accomplishments.

The meeting itself started with cordial greetings of all attendees, followed by welcoming remarks and club status updates by Al-Kudmani.

For USC alumnus Ahmed M. Omair, this was more than a formal get-together. "We sat together with mixed feelings, met with dear friends and classmates, remembering the school that held many of our pleasant memories," Omair said.

USC is one of the world's leading private research universities. USC enrolls more international students than any other U.S. university and offers extensive opportunities for internships and study abroad. With a strong tradition of integrating liberal and professional education, USC fosters a vibrant culture of public service and encourages students to cross academic as well as geographic boundaries in their pursuit of knowledge.

The consumption, production and trade of oil and its products – as well as the pivotal role of oil in energizing economies of both consuming and producing countries – have fashioned the global economic and energy issues for most of the twentieth century, and are expected to continue playing an important role for many years to come.

Therefore, this year's 17th version of MEOS will be the platform on which the club will hold its inaugural official event, an international reunion with participation of the distinguished Prof. Iraj Ershaghi, Director of USC's Petroleum Engineering Program, and Prof. Craig W. Van Kirk, a fellow alumnus and special advisor to the President of the Colorado School of Mines.

In addition, the event will include the distribution of the first issue of "From Coast to Coast."

# Talent Arrest and Thought Leadership

By Khalid Al-Omairen, Manager, Northern Area Production Engineering & Well Services Department, Saudi Aramco.

There are many books with different leadership qualities, attributes and styles that are believed to be indispensable for our technology evolving era to have the right mindset leadership. However, an important and rather critical individuality was unintentionally ignored. That is the passion to be a role model in creating a platform for new ideas.

Successful leaders are extremely futuristic individuals with a visionary mentality of things to come next. This innovative person should share his/her ideas and insights with others to benefit the organization as one entity. This person is known as a "thought leader", one who goes a long way to set his/her organization apart from others with a dynamic style to accommodate expectation and competition.

The concept of thought leadership involves the establishment of a resourceful work culture, with the constant simplification of routine processes, and adapting out-of-the-box approaches in anticipation of the possible complexity of future resolutions.

It is exciting to think of the future not just in terms of challenges but also in terms of opportunities and solutions. After all, what differentiates one leader from another is not only the leadership style but also the indulgence of being an observer and interpreter of the surroundings that always excite change accordingly. It is the intellectual focus that a leader should acquire to observe an event to come up with lessons learned for excellence. This capability is the basis for any business transformation.

My modest definition of transformation is our ability to evolve our thinking and modernize resources, with clear lines of managerial sight to drill down and drive the right behavior, which is defined as benefiting both the employee and the organization.

Thought leaders believe that we are living in an information era of knowledge abundance. Therefore, the creation of a totally different future that simplifies routine processes is only possible through gaining the appropriate knowledge to adopt new practices and transform current ones.  New ideas are produced and effectively put into perspective only when operating principles are well understood. For example, in understanding a new technology, thought leaders don't only communicate with subject matter experts, thought leaders conduct field assessments while getting insights from others who have employed this technology.

Thought leaders then orient the technology to their organization's requirements. Furthermore, thought leaders counsel international expertise and only adopt at-a-large-scale best practices when knowledge has become valuable enough to complete a process. The success of such partnership has resulted in several implementations that have improved safety, enhanced reliability and reduced cost associated with a direct business impact. The key success factor is their acceptance of learn-

> ... in understanding a new technology, thought leaders don't only communicate with subject matter experts, thought leaders conduct field assessments while getting insights from others who have employed this technology.

ing from mistakes, which enables thought leaders to build on success and search for best practices.

One of the basics for such a transformation is knowledge sharing. Globally, the key enablers for successful sharing of experiences, best practices transfer and establishing a creative work environment include:

• Willingness of juniors to learn.
• Ability and capability of seniors to teach.
• Work environment and culture intrusion.
• And most importantly, documentation and easiness of accessibility to knowledge.

Thought leadership is always complemented with talent capture and keep for a victorious strategy to create the environment for business transformation. Such futuristic leaders are rare commodity for the constraint to be instinctive, intellectual, well experience and dynamically adaptive to change. Experience is very crucial for this leadership to easily be a mind stimulant offering first-time business solutions. The experience will not only help him/ her to confidently promote new ideas, but also build wisdom to earn respect, credibility and influence. These leaders ought to be experienced and smart enough to be role models in problem solving and collaboration – with counterparts – for sustainable continuous improvement.

Thought leadership depends on fast learning and knowledge sharing, both external and/or internal, with a unique capability of producing lessons learned. These leaders rely on systematic approaches to reach the best conclusion. This approach will be a success only if the leader demonstrates confidence and support, and articulates the ideas with enough clarity that they can be converted into actions.

Additionally, thought leadership is best described as the ability to teach fast to solve predicaments or to improve employee readiness for a competitive future. Creativity for sustainable business excellence is the trademark of an organization with this leadership style. It requires inventiveness to integrate knowledge and people for best results.

The best example of such a paradigm shift, retaining our name as a best practices company, is the celebration of the 100th patent of Saudi Aramco in December 2010. The company was granted 125 patents in 2010 and 14 patents in 2011. In addition, there were 57 patent applications in 2011.

In fact, Saudi Aramco will need to tackle the future challenges in the short-, medium- and long-terms as complexity is rising.

This issue was identified by Amin Nasser, Saudi Aramco's senior vice-president of Upstream, in his address to the Dhahran Geosciences Society (DGS) during a monthly dinner meeting in 2008. In his speech titled "75 Years Past to 75 Years Ahead: A Journey of Discovery," he identified the four main challenges: natural resources, human resources, technology and reservoir stewardship. These challenges can be met by thought leadership and its natural attraction to those who want to make a difference.

Finally, operational departments within Saudi Aramco are the best candidates for thought leadership. These organizations are running critical operations that demand continuous improvement as facilities age and processes become more complex. Deployment of new technologies is gaining momentum at all times to streamline processes. We must ensure that our leadership styles continue to improve as well.

Khalid Al-Omairen has 25 years of experience in the Oil & Gas industry. His first assignment right after graduation was with Production Engineering for Aindar Field in 1986. Later on, he worked as a Foreman and a Superintendent for several offshore and onshore facilities, including Northern Area Oil Operations (NAOO) Well Services Division. Currently, Khalid is the Manager of Northern Area Production Engineering & Well Services Department. He has a unique passion to create a work culture – attached to continuous simplification of the routine through the adaptation of new technologies and process improvement – that is proactive and flexible enough to accept change and resist returning to old time thinking. Khalid received his BSc degree in Petroleum Engineering from the University of Louisiana, Lafayette, LA.

# Steamflooding at Wafra Moving Closer to Breakthrough

**Production at the First Eocene Large Scale Pilot for the Steamflood Project at Wafra Joint Operations in the onshore Partitioned Zone increased more than six-fold over the pre-steam baseline in direct response to steam injection of its 25 producing wells.**

Steamflooding of the heavy oil carbonate reservoirs at Wafra Joint Operations in the onshore Partitioned Zone (PZ) between Saudi Arabia and Kuwait is advancing towards the first commercial application of a conventional steamflood in a carbonate reservoir, with the progress of the Large Scale Pilot for the First Eocene Steamflood Project (1E LSP) and ongoing modeling and other studies. By year-end 2010, 1E LSP had recorded an impressive greater than six-fold jump in production compared to its pre-steam production baseline and demonstrated increased production in direct response to steam injection.

Steam injection testing in the Second Eocene reservoir also began with a four-month Small Scale Test (2E SST) completed in early January 2011. Budget has been approved for a Second Eocene Large Scale Pilot (2E LSP) that will use existing steam generation and other surface facilities at the 1E LSP site. The 2E LSP is scheduled to be operational by mid-2013.

## First Eocene LSP: Impressive Response

From a nonsteam "cold production" baseline of around 200 barrels per day, production by year-end 2010 in the 1E LSP was boosted to an average 1,500 bopd, and peaked even higher, the result of a combination of continuous steam injection over 18 months into the pilot's 16 injector wells and cyclic thermal injection into selected wells. "There is a clear correspondence between injection and production. When we are injecting steam, we are increasing production," says David Barge, 1E LSP Manager. "We have not calculated recovery yet, but we saw a good production response in this very early stage."

In January, 1E LSP commenced a planned shut-in for a number of months to recomplete the steam injection and oil production wells to the B zone, a higher zone in the reservoir, and carry out planned modifications and repairs to the surface equipment. Chevron engineers and geoscientists continue to evaluate reservoir conditions, performance to date, and the reaction to steam injection during this time to help them zero in on the best alternative for steamflooding.

Simultaneously, the 1E SST continues to yield valuable insights for developing effective mitigation measures for dealing with scale buildup in wells following the steam breakthrough and downhole corrosion from the hydrogen sulfide in the oil. Data from the 1E SST is reducing the technical and economic risk and uncertainty for full field steamflood development (FFSF) so that a final investment decision (FID) can be made in late 2013 and start up of steam injection in 2017.

"We continue to pass positive signposts in all our pilots," observes Bill Higgs, SAC Senior Vice President-Operations. "With these 'first of a kind' pilots, there's not a sudden point where we declare victory, but what we're gaining is information that's being fed every day to the full field project team-- and this is one of the reasons why we're running our Full Field Development Project in parallel with the LSP. We're narrowing the range of outcomes to a point where we can be confident to make the FID."

Left: The Second Eocene Small Scale Test for the Steamflood Project has demonstrated good steam injectivity for the Second Eocene reservoir, and testing results will be use in the design of the Second Eocene LSP.

Since first steam injection in June 2009, the 1E LSP team and FFSF Phase 2 Development team have been determining recovery efficiency and production response, monitoring variability of response by pattern, identifying operating issues associated with a carbonate reservoir, and determining the cost of installation and operation. The $340MM pilot includes 25 producer wells, 16 steam injection wells and 16 temperature observation wells, in 16 patterns. As of the end of 2010, the project had logged over 4.6 million man hours without a lost time incident.

## Second Eocene: Good Steam Injectivity

Steam injection for the 2E SST at Wafra commenced in September 2010 and continued as planned for its single injector into early January 2011. Results from the steam injection test were positive as test data demonstrated good steam injectivity for the reservoir. Cyclic steam stimulation response tests are being carried out, and their results will be used in the design of the 2E LSP.

The 2E LSP is currently in pilot design, with steam generation and other surface equipment for it to be provided by current 1E LSP surface facilities. Drilling of its 24 producers, 7 injectors and 12 observation wells is scheduled to start in 2011, and full injection rates achieved to be during the second half of 2013.

Reservoir simulation modeling and analysis, the running of various economics scenarios and development of a prioritized opportunity catalog of future thermal pilot tests are now underway for the 2E LSP by the Wafra JO Thermal Team in Houston, TX. The team is also tasked with scoping out and developing implementation plans for building the organizational capability required for FFSF.

LSP autotechs and operators troubleshoot an electric control valve actuator for process water for the LSP water plant.

**Produced water is cleaned to a high purity in the two evaporators of the water plant for the First Eocene Large Scale Pilot before being converted by its 10 steam generators into high purity steam for injection in the field's First Eocene reservoir.**

## Full Field Steamflood: Mammoth Scope

FFSF entails many critical strategic design decisions with far-reaching implications for production and project economics. The envisioned scope of the project is huge: An estimated total of 10,000 wells will be required for steam injection, temperature observation, and production, along with stand alone power and steam generation and other vital surface equipment. When developed, the Wafra FFSF is forecast to be the largest steamflood in the world.

With about three to six barrels of steam required to produce one barrel of oil, fundamental decisions on sourcing water and fuel to produce the mammoth volumes of high quality steam required will be critical for the commerciality of the project. Already, Chevron-led teams are seeking to secure sizeable, long term supplies of the fuel, water, and electricity required for generating the vast quantities of steam required for FFSF.

The steamflood project will transform operations in the onshore PZ and shape its destiny for decades to come. It promises to increase recovery by an order of magnitude, based on intensive field studies, modeling, steamflood pilots now underway and in development for the future at Wafra, and Chevron institutional expertise as the world leader in heavy oil, including steamflooding.

Chevron has employed steamflooding for more than 50 years in the San Joaquin Valley in California (see sidebar) and 30 years at Duri Field in Sumatra, Indonesia, to boost recovery from 10 percent to 50-80 percent of the original-oil-in-place, and more than two billion barrels of oil from each.

## Full Field Development: Transformative Potential

Clearly, the potential is huge. Net original-oil-in-place of around 18 billion barrels of Eocene at Wafra is actually more than double that at Duri, so the expectation is that a FFSF at Wafra for the First Eocene alone will recover considerably more barrels of oil than the one at Duri. Estimates of steam flood reserves potential are about 20-40% of the targeted reservoir's oil-in-place. It's estimated that each 1% increase in the recovery rate at Wafra will yield 100 million barrels in additional reserves.

Continuing with primary, nonsteam recovery of the Eocene reservoirs is estimated to recover only 5%-12% of the original-oil-in-place, with the First Eocene at the lower end and the Second Eocene at the higher end. It's become increasingly difficult to find promising new prospects and maintain production from existing wells employing only primary production at Wafra.

FFSF promises to generate thousands of jobs for skilled personnel in the PZ, and depending on additional application of Chevron's technology in carbonate reservoirs outside the PZ, tens of thousands of jobs around the Middle East as production rises and useful field lives are extended by multiple decades.

"Already, the development of steamflooding at Wafra is promoting technology transfer and development of local expertise and organizational capability," notes Saudi Arabian Chevron President Ahmed Al-Omer. "Forty Saudi and Kuwaiti nationals acquired skills and experience through an 18-month classroom and field training program at Chevron's steamflood operations in California for young steamflood operators, technicians and shift supervisors. Dozens of others have been gaining valuable experience and skills through long term global work assignments with Chevron operating locations and the Heavy Oil Center in Bakersfield, CA, and the Phase 2 FFSF Project Development team in Houston."

As *The Financial Times* noted in a December 2010 article on steamflooding in the PZ, "The tiny field represents big hopes on the part of Chevron." The prize at Wafra alone is indeed great. But beyond the PZ, some estimates suggest as much as 60 per cent – and possibly more – of the world's remaining hydrocarbons are locked in carbonate reserves, many in the Middle East. On a similar scale, an estimated 50% or more of the world's remaining hydrocarbons are heavy/extra heavy oils-again, much of it in the Middle East – only 10% of which has been produced to date.

**An LSP specialist and operators compare treated water from the LSP water plant evaporator to untreated produced water. The specialist previously was one of the mentors for the 18-month field and classroom training at Bakersfield, California, in which the operators participated.**

"The recent precedents set by the technology breakthroughs for producing extra heavy oil and shale gas make it apparent that such previously overlooked resources as the heavy Eocene of Wafra's carbonate reservoirs can become economic to produce," says Higgs. "To top it off, we know where the oil is – the field area and the net oil-in-place are huge. Clearly, steamflooding success in the PZ promises to be a game-changer."

# Chevron's Heavy Oil Steamflood at Bakersfield

In the late 1960s, steamflooding boosted output sevenfold at California's Kern River Field. Today, reservoir surveillance, 3D reservoir modeling and horizontal drilling are extending the heavy oil field's economic life for years to come.

Steamflooding involves injecting steam into heavy oil reservoirs to heat the crude oil underground, reducing its viscosity and allowing its extraction through wells. In addition to employing this enhanced oil recovery technology to produce heavy oil from sandstone reservoirs at Kern River for 50 years, it has been applied at Duri in Sumatra, Indonesia, for 30 years, and now is being tested in the carbonate Eocene heavy oil reservoirs of the onshore Partitioned Zone between Saudi Arabia and Kuwait.

Discovered in 1899 and estimated to hold over 3.5 billion barrels of original oil in place, Kern River Field near Bakersfield, in California's San Joaquin Valley northeast of Los Angeles, was a sleeping giant until the late 1960s, when steamflooding began and production ramped up from 19,000 bopd to over 142,000 bopd by the mid-1980s. For most of the period between 1980 and 2000, steamflooding sustained daily oil production over 120,000 bopd.

Kern River remains one of the largest heavy oil fields in the US, still producing about 78,000 bopd. The field produced its 2 billionth barrel of heavy oil in 2007, and more than 20,000 wells have been drilled. Since the 1990s, continued innovations have enabled further improvement in reservoir recovery, reducing production decline rates and extending the life of the field.

With nearly 50 years of steamflood history, Kern River Field has served as a natural laboratory for the development and refinement of completion and reservoir management technologies for steamfloods. Following the successful use of bottomhole heaters and a short period of hot water injection, steam injection testing was initiated in 1962. This breakthrough in recovery technology initially took the form of cyclic steaming of producing wells. Starting in the late 1960s, full steamflood development was implemented, with dedicated steam injector wells drilled in the center of groups of four or eight producing wells typically drilled in patterns covering roughly 2.5 acres.

Due to the long history of steamflood operations in Kern River Field, there is abundant performance data on steamflood response, both production information and reservoir surveillance data. This information has been used to develop prediction tools used for forecasting performance in new steamflood developments in Kern River Field and in analogous sandstone reservoirs.

Other tools employed include recording measurements of one or more physical quantities versus depth or time, or both, in or around wells in a reservoir, such as oil saturation and fluid drainage; dedicated temperature observation wells to monitor the oil recovery process with temperature and other surveys; and use of 3D geostatistical modeling techniques and full-field reservoir models to visualize static and dynamic reservoir data.

Chevron's International Heavy Oil Center research facility, located at Kern River Field, further enables collaboration and testing of new tools and technologies to enhance recovery for the field and other heavy oil assets around the world.

Today, continued innovation and application of technology in steamflooding, reservoir surveillance and 3D reservoir modeling have enabled Kern River Field to produce more than half of the original-oil-in-place and continue to provide significant production and long-term value to the operator. Through the use of these technologies, Chevron has developed efficient heat management practices that are industry-leading and enable steamflood oil recovery at reduced costs. These heat management practices will enable the field to continue to produce for many more years, maximizing recovery and reaching the full economic potential of the asset.

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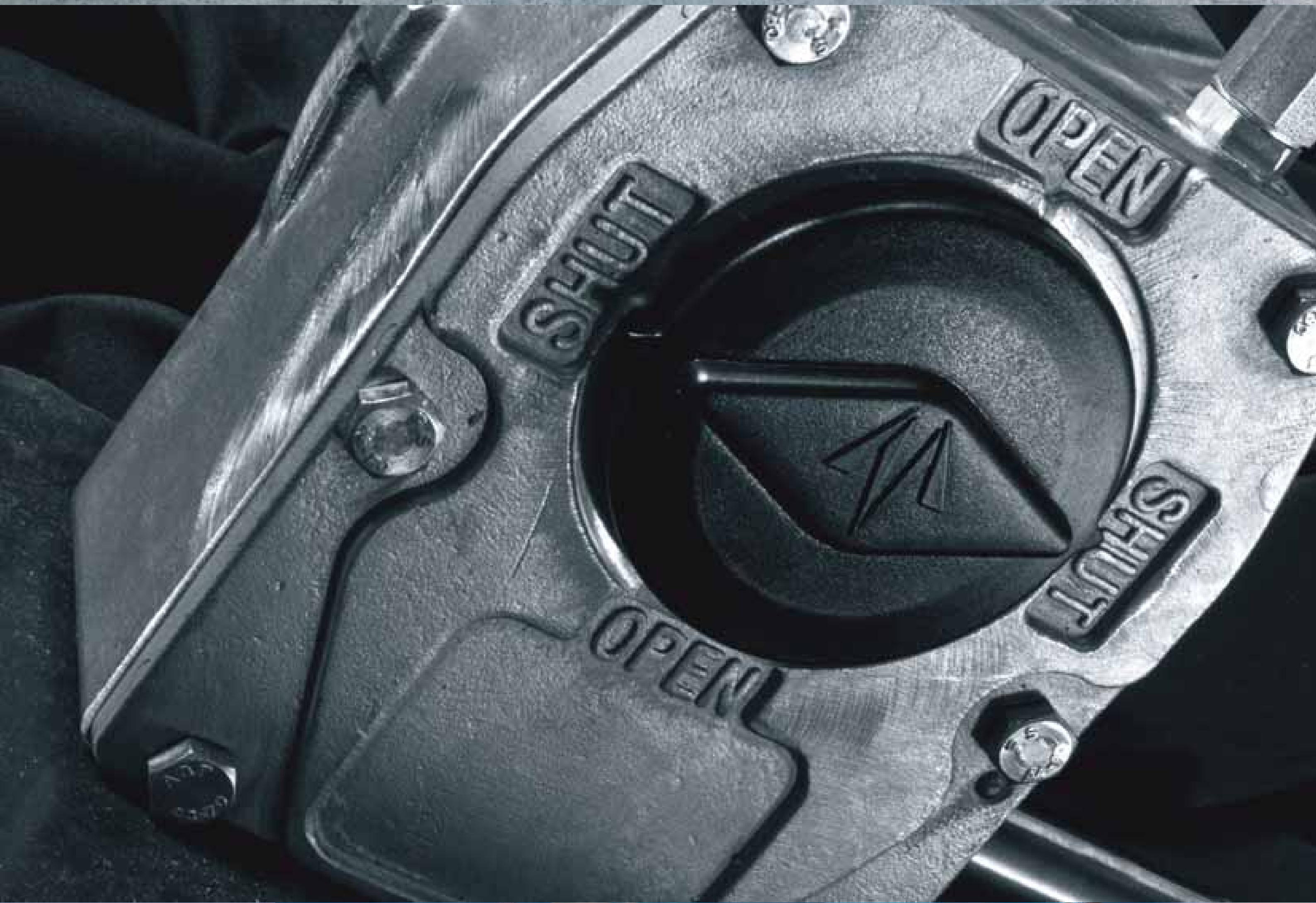


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# Innovative Applications to Enhance the Performance of the Oil & Gas Industry

By Karam Al-Yateem; Saudi Aramco.

Presently; 50,000+ hydrocarbon fields have been discovered and explored. In today's uncertain environment, deeper and more complex formations and unconventional reservoirs need to be explored and carefully produced. These fields are progressively becoming marginal in hydrocarbon accumulations. Currently, conventional techniques yield less than 50% of producible oil in place. Therefore, the success of the Oil & Gas (O&G) industry and the ability to deliver the current and future energy requirements are greatly dependant on the continued ability to push the envelope of technology. Intelligent fields and smart wells are new technologies that will improve recovery. The implementation of technological advancements results in a positive impact on field performance such as extending the production life of wells, perfecting sweep efficiency and eventually maximizing the oil recovery in real time fashion. The real challenge, however, is to extract the maximum possible amount of hydrocarbons from the ground smartly, effectively and efficiently, find every last commercial barrel yet to be discovered and expand the recoverable base.

## Smarter Well Completions for Optimal Hydrocarbon Extraction

Not too long ago, vertical wells were dominant in the industry followed by slanted drilling. Then came horizontal drilling followed by multilaterals and multizone drilling, and completions with maximum reservoir contact (MRC) laterals and extended reach wells (figure 1). These advancements in drilling, articulate further optimized field production or injection programs, improving reservoir performance, achieving higher extraction ratios, and reducing field development and intervention costs.

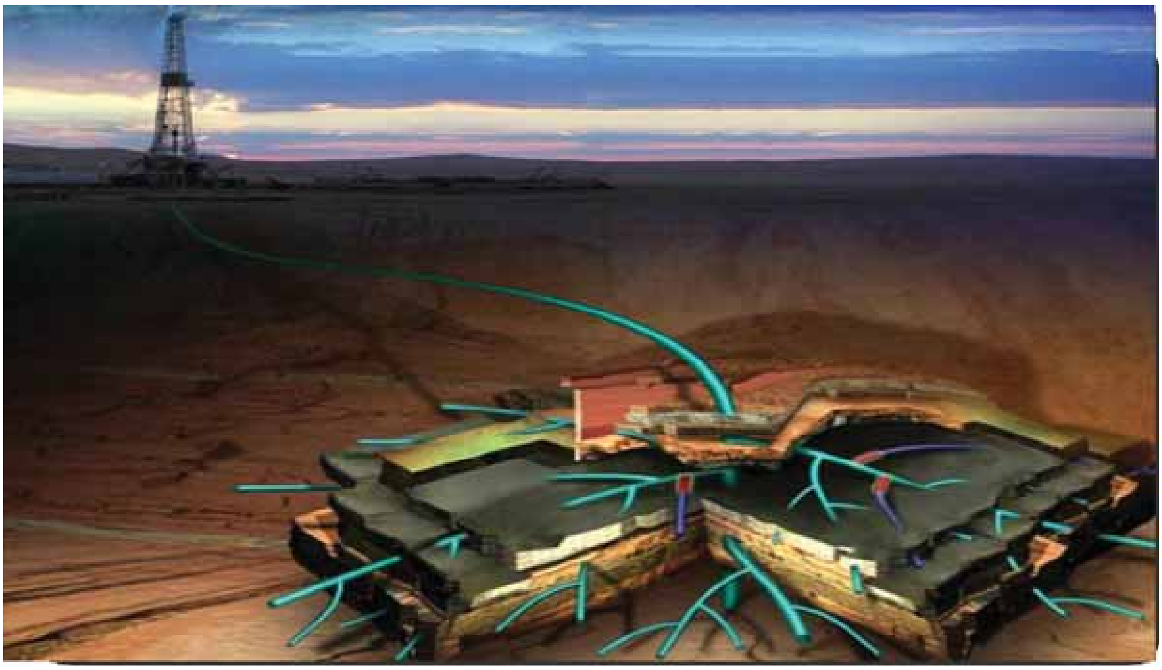

**Figure 1: New horizon of multilateral extreme reservoir contact drilling: courtesy of Saudi Aramco.**

> Engineers cannot use sound judgments and make quicker informed decisions without intelligence of what is going on in the reservoir.

This, very expensive drilling and well completion procedure, can easily be economically justified with the overall improvement in reservoir performance and increased recovery. Engineers cannot use sound judgments and make quicker informed decisions without intelligence of what is going on in the reservoir. For example, if for a multilateral well; the water invades one of the laterals; the overall well performance will be affected greatly by the increase in water cut. Alternatively, if internal control valves (ICV) exist along with sensors that can predict the water movement, better and more proactive reservoir management can be made. Hence, the integration of Intelligent Well Completion (IWC) with the installation of permanent monitoring

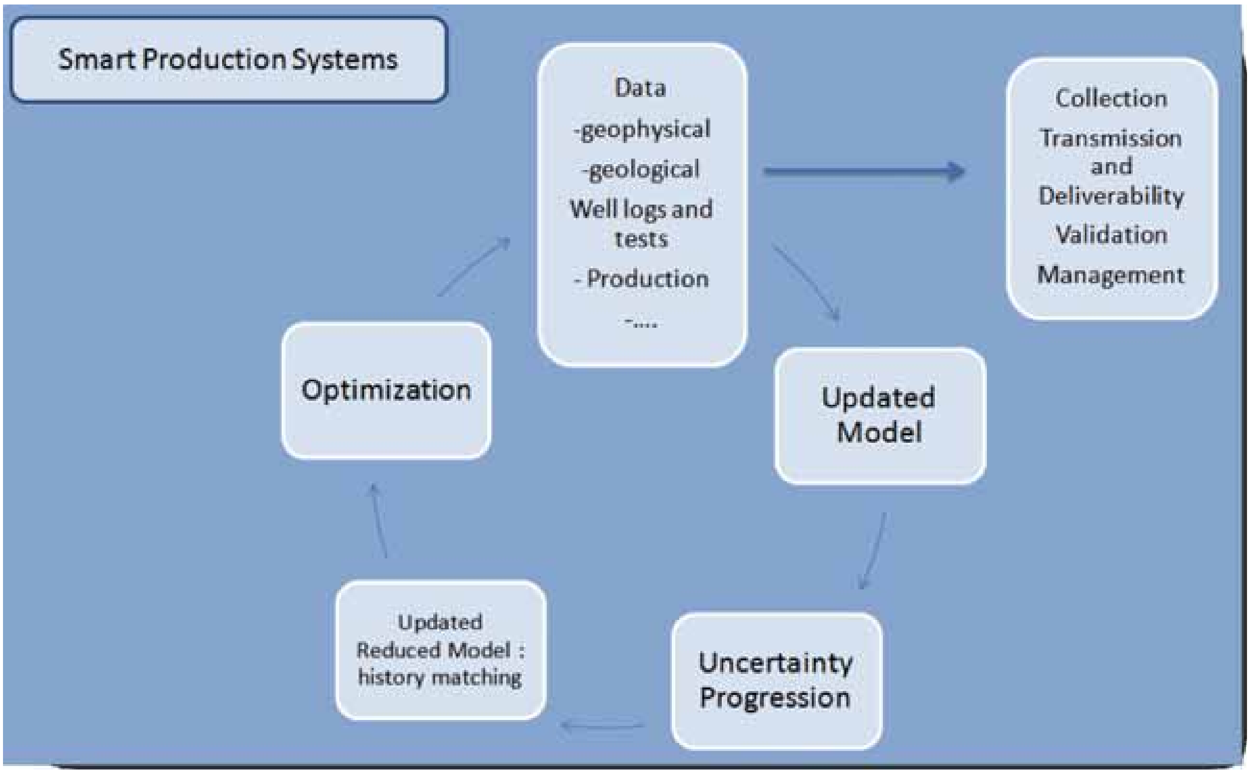


Figure 2: Smart systems data collection, processes and utilization.

> The fundamental requirements for a smart system to exist are downhole control, permanent monitoring systems and sensors, surface monitoring and control, zonal isolation devices, power and communications, automation and control of data acquisition, management software and system accessories.

devices serve as the economic justification path between sophisticated drilling procedures and complicated well completion, and exploring and producing hydrocarbons from conventional mature oilfields and unconventional reservoirs. Thereby, IWC can be defined as the process of making a well ready for production (or injection) with assembly of downhole tubular and sensor equipment for the purpose of enabling safer, smarter, more efficient, more effective, more economic and optimal production or injection from an oil, gas or water well, in a timely manner. The fundamental requirements for a smart system to exist are downhole control, permanent monitoring systems and sensors, surface monitoring and control, zonal isolation devices, power and communications, automation and control of data acquisition, management software and system accessories.

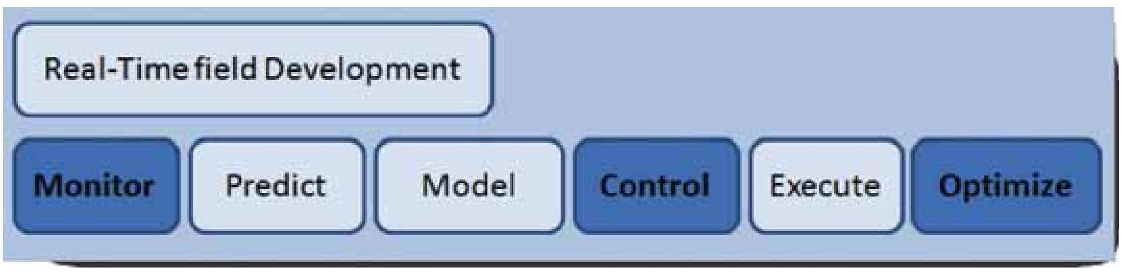


**Figure 3: Desirable actions of smart systems.**

> Soft computing methods provide the ability to manage and analyze vast quantities of data, a task that would not be possible with a manual system.

## A Synergetic Integration

The deployment of smart completions and permanent monitoring systems enables real-time monitoring and control of the subsurface and surface equipments through systems like Supervisory Control and Data Acquisition (SCADA). The successful integration of intelligent well control to the SCADA console provides the ability to control the downhole valves while simultaneously monitor data from the downhole sensors and multiphase flow meters on surface. Huge amounts of data are transferred every second and must be constantly interpreted so that proper decisions can be made on time. Critical decisions are often delayed in the process of attaining better data understanding and explanation. Soft computing methods provide the ability to manage and analyze vast quantities of data, a task that would not be possible with a manual system. This ability results in a system that uses real time monitoring data and detects the current field conditions, anticipates field requirements and makes decisions in a timely fashion under the overall supervision of engineers. The result isappropriate data management, leading to the best possible usage of the huge volume of field information gathered (figure 2).

Real-time communication minimizes downtime and production loss. It also reduces safety concerns by minimizing onsite personnel visits and handles systematic precautions. The main elements of intelligent fields are flow monitoring, flow control and flow optimization (figure 3).

Limitations for effective and efficient smart systems with some variation for each factor from one company to another include: (1) cost of technology, (2) trained manpower, (3) mature fields, (4) hot, harsh, deep, remote environments, (5) integration of operations (surface and subsurface) and (6) power and communications. The direct benefits obtained from the utilization of intelligent well technology in particular, and employment of new technologies in general, can be summarized as follows:

• Increase hydrocarbon recovery efficiencies through more insightful management of reservoir injection and production processes and real time data acquisition.
• Augment, accelerate and optimize production. Improvement in reservoir performance, productivity index and lengthening of decline curve plateau.
• Reduce capital expenditure (CAPEX) via developing assets with fewer wells.
• Reduce operating expenditure (OPEX) by reducing intervention and producing less water.
• Reduce health, safety and the environment (HSE) exposure by helping the operators to remotely optimize production without frequent visits and interventions.

Intelligent wells and completions have been around for 10+ years; the number of installations has been growing fast around the world and is estimated to be in excess of 900. Many National Oil Companies (NOCs), International Oil Companies (IOCs), Educational Institutions (Stanford and University of Southern California "USC") and Service Companies are investing time, money and effort in the Intelligent-field concept. Saudi Aramco has a very advanced Intelligent-Field program that was manifested clearly in Haradh-III increment and many other fields like Abu Hadriyah–Fadhili–Khursaniyah field (AFK) with wells equipped with remotely operated chokes, emergency shut-down systems, permanent downhole monitoring systems, compact multiphase flow meters and variable speed drive pumps where applicable. Chevron calls it the i-field™ program and has an educational collaboration with USC through the Center of Interactive Smart Oilfield Technologies (CiSoft), Shell names it smart fields. Norway's Statoil refers to Smart wells and it is called the Automation and Smart Field by Abu Dhabi Company for Onshore Oil Operations (ADCO). The Smart Fields Consortium run by Stanford has many contributors (Saudi Aramco, British Petroleum "BP", Norwegian University of Science and Technology "NTNU", IBM, Total, Baker Hughes, Chevron, etc.). IBM calls it the intelligent oilfield and has opened five facilities focused on the global oil and gas industry to provide ways to help petroleum producers test and use new technologies that will lower costs and make oil recovery easier, and more efficient and intelligent.

## Reference

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# Step Change Technology for Running Tubulars

By Lance Davis, Deep Casing Tools Limited; Abdulaziz Al-Othman, Gotech Limited.



This paper was prepared for presentation at the 2011 SPE Saudi Arabia Section Technical Symposium and Exhibition held in AlKhobar, Saudi Arabia, 15–18 May 2011.



## Abstract

Oil and gas well construction requires the installation of tubulars at a specific depth, prescribed for reasons of mechanics, formation pressure and wellbore integrity or accessing reserves. Deepwater construction has an additional need to also land all strings in the subsea wellhead with precision. The industry has recognized this significant problem for some time. There have been many instances of failed well programs where critical depths have not been secured. A step change technology solution has been created to reduce well construction risk, applicable to all casing strings, liners and completion strings.

An elegant solution has been created with a new family of tools based upon a unique mud motor. Exceptionally, the motor can be drilled up using a normal polycrystalline diamond cutter (PDC) bit in minutes, and for any intermediate string, the cemented shoe track and motor are drilled with the next bottom hole assembly (BHA). The result is a time saving, practical, cost-effective solution which can be systematically applied to ensure all tubulars are placed on depth.

Similarly, with the advent of complex, expensive completion systems, there is an absolute necessity to land on target. An ideal solution also eliminates the need to rotate the completion string. One of the new technologies does this, and provides a gun barrel borehole right in front of the completion. Results of applying this technology are presented in this paper.

To date the technology has provided a new approach to running tubulars, and mitigating operating risk. It

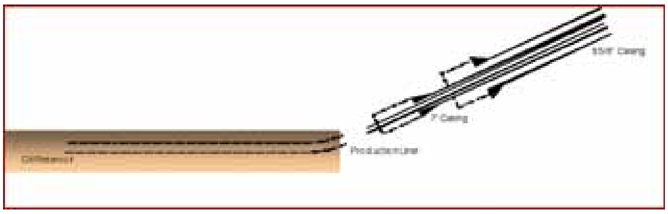

Figure 1: Root Cause Analysis.

provides a significant boost to ensure well integrity and has clearly demonstrated the ability to recover collapsed hole and land completions across the entire reserves section, delivering an outstanding return on the technical investment.

## 1. Introduction: Solving an Important Industry Problem

Adverse well bore conditions, instability, irregularity, doglegs, fill etc., often result in inefficient and incomplete casing running operations, both in terms of costly non-productive time and potentially lost production. If the rig is equipped to do so, it may be possible to overcome such problems by reaming. However, as casing strings get longer and heavier, and for rigs without a top drive or where other factors lead to a limited ability to rotate the casing, there is currently little option but to accept that casing placement problems are just a "cost of doing business". The industry problem is quite clear, but there do not appear to be Key Performance Indicators on the percentage of casings run to 100 per cent of target depth. Recent events in the Gulf of Mexico and elsewhere also emphasize well integrity, ensured in part by following the plan, landing casing on depth, and obtaining a well cemented tubular.

Much investment has been made to develop new and improved drilling and completion technologies, but the same cannot be said of investment in this fundamental operation – the placement operation. Certain fields, certain formations, certain depths generate perennial casing landing issues, but in reality all fields have

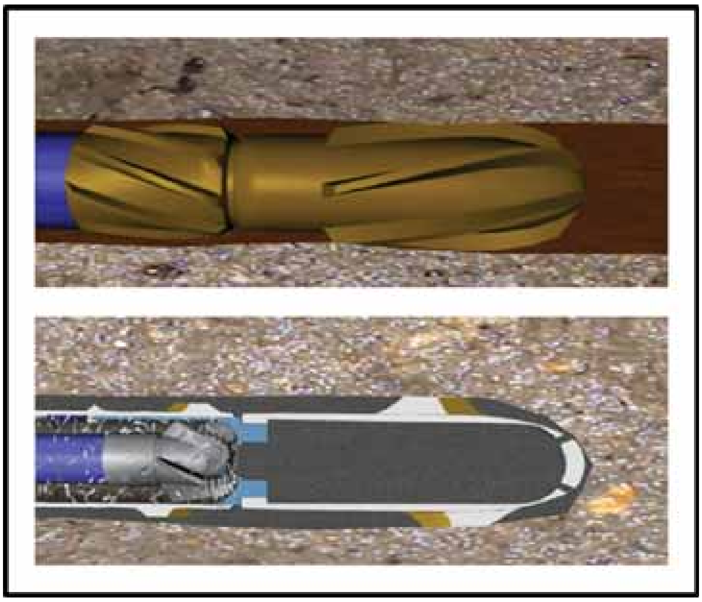

Figure 2 (top): Reamer System

Figure 3 (bottom): Drilling of Cemented Motor & Reamer System

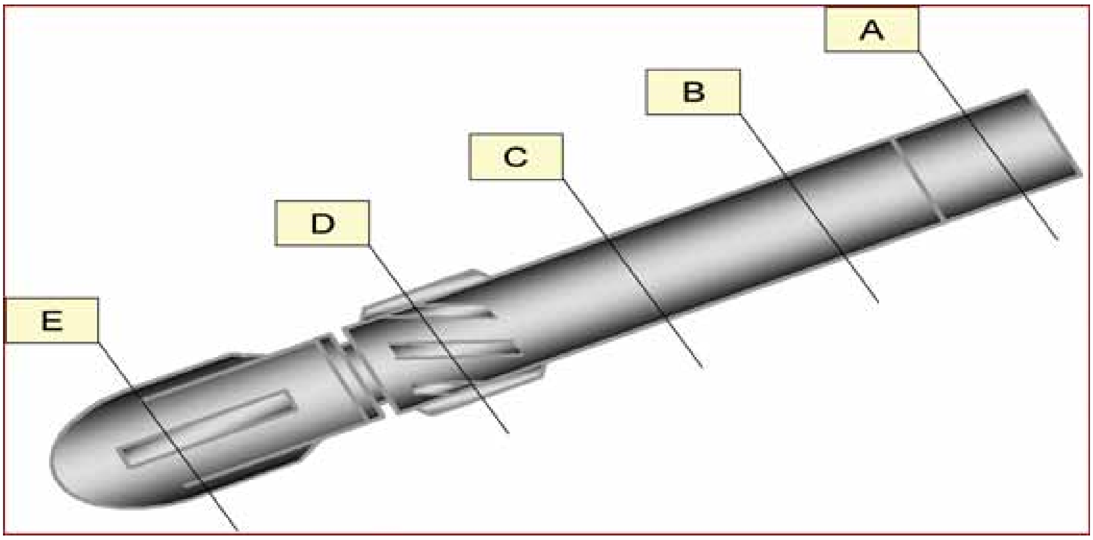


Figure 4: Drillable Reamer, Stabiliser and Power Module.

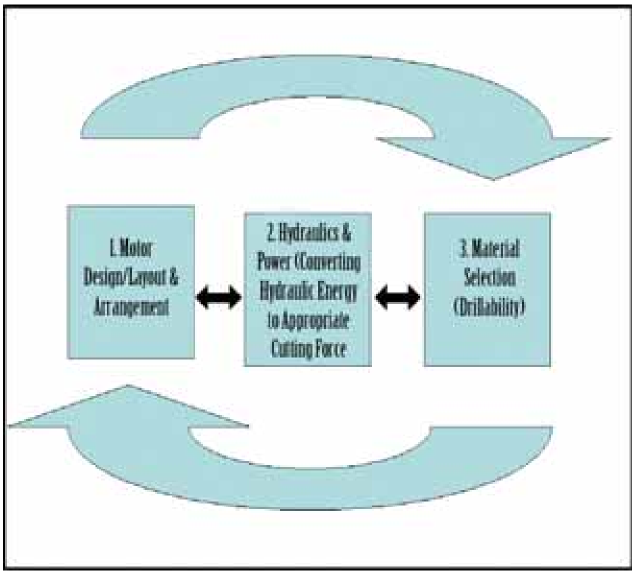


Figure 5: Design Iteration.

records of landing casing off depth. This shortcoming seems to occur despite best efforts in mud technology, circulation methods, dog leg minimization and centralization system.

There is always a common thread, a root cause, exemplified in Fig. 1, where failure to land 9⅝″ casing eventually lead to loss of a North Sea well.

Cost of failure to run the casing to the design depth comes from many sources, including cost of drilling the unused hole, cost of running, pulling and rerunning casing, cost of any subsequent casing plan revision. There are the associated risks, including as a minimum the risk of landing above geopressure plan depth, the risk of drilling through unused rat hole, notwithstanding the risk of reputation damage of failing to deliver to plan.

Given that industry recognition of this problem is often reluctant, the process of introducing new technology to the industry must be well managed.  Adoption of new technology is not an automatic step. From the start of the technical development it was planned to introduce some broad conditions in order to promote easy adoption. These conditions became constraints,

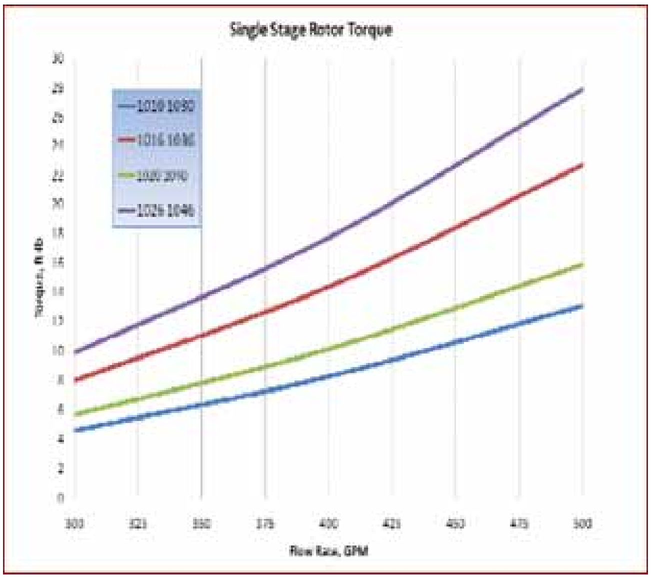


Figure 6: CFD EStimates.

which proposed that for best acceptance it would be ideal to provide a system that allowed conventional drilling of the well, conventional casing running and cementing, and that was not only fundamentally easy to use but also applicable to any rig type or size. There were more important operational goals; of primary importance the design must not introduce any risk to the existing well control or casing running process, and ideally, for reasons of safety there should not be additional personnel required to operate said equipment.

## 2. Proposal

Hence, as an alternative to casing while drilling the entire well section, it was decided to provide in situ reaming right at the point of casing running, with a downhole motor that did not need retrieval. The first concept plans were drawn in early 2007, and received a government sponsorship funding the launch of feasibility studies.

The proposed concept comprised the provision of a sacrificial mud powered motor, with a specific life, integrated with a drilling or reaming shoe assembly. The critical feature of this concept is that the motor will be manufactured with materials which enable a drill bit to easily and readily drill-out the product in a similar fashion to a cement plug.

The schematics of Fig. 2 and Fig. 3 show the concept. This progressed to the tool mockup of Fig. 4, where the principal system components are outlined as follows;

A. Top Sub – Joins the tool with the end of the string via proprietary joints. This section can house telemetry to transmit key information such as torque, compression or directional information.
B. Mud Motor – There are a number of mud motor types, each with different torque, power and speed characteristics (e.g. axial flow turbines, positive displacement motors, etc.)
C. Drive Shaft is integral as one piece component – provides rotation and power to the cutting structure.
D. Near bit Stabilizer – lifts and centres the casing/completion string to the middle of the borehole
E. Circulation Valve –to ensure that mud or cement can be circulated after placing the casing at depth.

## 3. The Design Conundrum

The parallel technical and economic challenges became very clear. The design had to realise an economically viable product, based on the need for a low-cost, disposable product with a limited life. The motor had to deliver adequate design torque and speed for a specified period. Design life beyond the expected set goals

> "... the failure mechanism of the material, during the subsequent drill through process and independent of the type of drill bit, had to be considered and be predictable to ensure that the drilled material is then capable of being pumped back to surface without causing further remedial operations."

would be a waste, as the motor would be destroyed in the normal course of action. The entire assembly had to be drillable by a PDC bit which can then drill ahead onto the next section. Whereas most oilfield drilling equipment is designed and improved over many years to yield an ever demanding mean time between failure and a low cost maintenance cycle, the design requirement of this proposed technology is to design f or a specific life, and leave as little residual value as possible.

As a consequence the three areas of iterative technical work are shown in Fig. 5.

## 4. The Design Method

**Motor Design/Layout & Arrangement:**
Selection of optimal hydraulic motor design was pivotal, as this set the overall assembly dimensions, power limitations. The following work packages were actioned:

- Research and initial engineering studies into motor options; leading to a high level motor specification.
- Design for drill through – The motor had to be constructed with materials drillable during a subsequent drill though operation. In addition, the failure mechanism of the material, during the subsequent drill through process and independent of the type of drill bit, had to be considered and be predictable to ensure that the drilled material is then capable of being pumped back to surface without causing further remedial operations.
- Design axial and thrust bearings to allow the motor and cutting structures to freely rotate with the adjacent non-rotating parts, and with the option of also being drillable.

Figure 7: Prototype in Test tank.

Figure 8: Prototype on Dynamometer Bench.

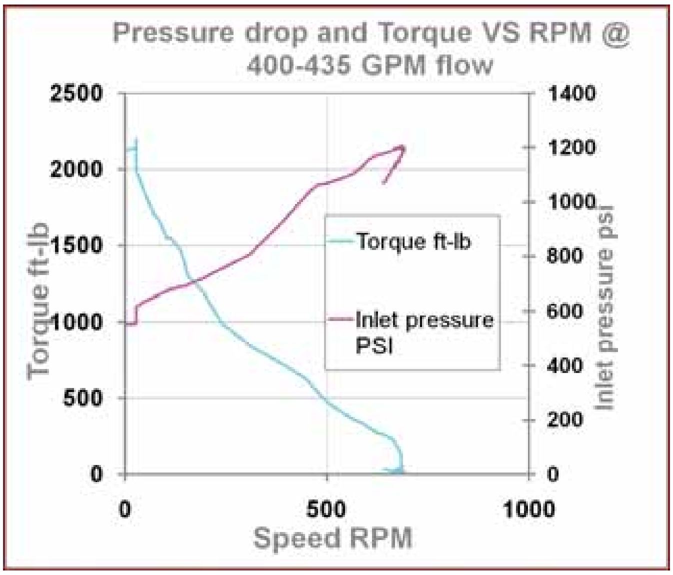


Figure 9: Dynamometer Output.

• Design cutting structure geometries for the reaming shoe. Blade geometries and material selection had a fundamental impact on this novel concept. The design torque for reaming was clearly less than that of drilling the original hole, the cutters had to take small cuts to ensure circulation to surface, there could be no tendency of the reamer bit to establish new hole, and the entire system had to be drillable.

**Hydraulics & Power:**
It was critical that the entire assembly produce sufficient power to rotate the cutting structure to enable the drilling or reaming away of any downhole obstructions. The following work packages were actioned:

• Engineering work to assess suitability of motor design and optimization of hydraulic and mechanical engineering to maximize start up torque and power characteristic within a short assembly.
• Technical and economic assessment of options associated with the power drive mechanism for the cutting structure.

Figure 10: Test Rig.

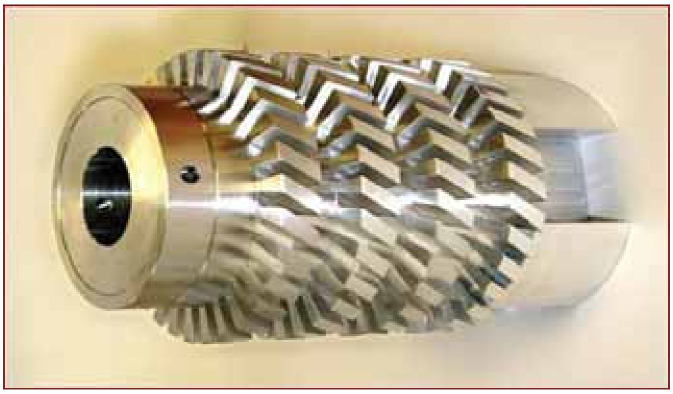

Figure 11: Dummy Turbine.

Figure 12: Drill Cuttings for Analysis.

• Computational fluid dynamics (CFD) modelling of the pressure drop across each component, subsystem and through the entire system to assess operating performance under different surface pump flow rates. An example of theoretical torque generated by CFD modeling is shown in Fig. 6.

**Material selections:**

• Conduct research leading to key materials selection, assessing benefits and limitations of using soft malleable materials (e.g. aluminum, leaded bronzes, plastics etc.) versus ultra brittle materials which shatter upon impact (e.g. ceramics, plastics, glasses). Tests were

> In order to prevent in-house engineering work to be done in isolation from the eventual users, the joint industry program established with one operator funding provided direct access to drilling engineers and operator QA/QC systems.

made on a range of malleable materials to produce fine swarf from a drill through operation, and brittle materials which shatter into sized particulates in a similar way to windscreen glass.

- Assess design layout configurations for likely bit wear from the drill through operation and to guide the drill bit through the sacrificial structure. Optimize the design for minimum parts, thus minimizing potential areas of risk. Optimize the mechanical shape of all parts to improve drillability.
- Evaluate and select optimum bit type based on the above.

## 5. The Prototype

In order to prevent in-house engineering work to be done in isolation from the eventual users, the joint industry program established with one operator funding provided direct access to drilling engineers and operator QA/QC systems. Regular meetings were held with drilling staff to critique the design, and establish performance goals. The initial goals were set to provide reaming time for at least 20 hours, a torque capacity of 1500 ft-lbs with a high speed reaming action of up to 800 rpm. The drill out time was set at 6 hours, a figure based on a reasonable spread rate cost versus the benefit gained by landing the casing on depth. Prototype tools, with a maximum design length of 16 feet, were constructed to join directly with casing joints.

There was significant debate on the amount of torque required in a reaming tool. In traditional methods, turning the casing or drill pipe from surface can lose significant power due to frictional losses delivering an unknown torque at the reamer shoe, if any. The maximum available torque from down hole drilling motors varies with manufacturer, but it was considered that that adequate torque at the cutting face would be 6000–8000 ft-lbs to drill virgin formation at rotational speeds of 100-150rpm. It was then assumed that to clean the hole of collapsed, mechanically weak debris, and to ream the face of a swelling salt or shale would be 20 per cent of the maximum original drilling torque. The power of any downhole system is defined as torque multiplied by rotational speed, and is obviously dependent on the hydraulic capacity of the rig pumps. Thus for a given hydraulic power supply, the prototype should possess a high speed reaming action.

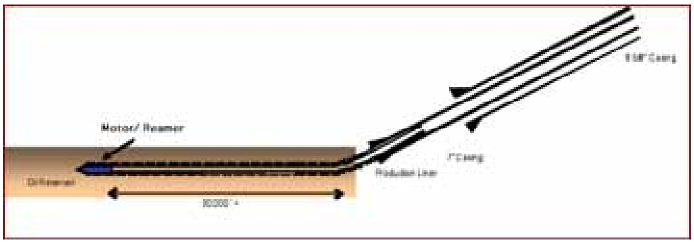


**Figure 13.**

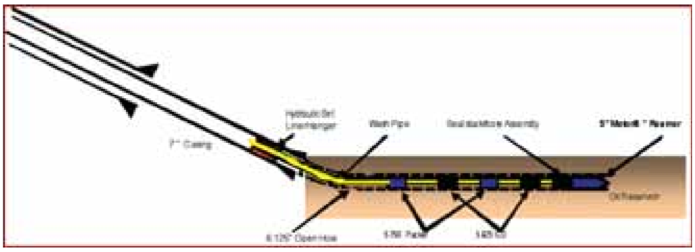


**Figure 14.**

Flow tests were carried out in Aberdeen (Fig. 7) pumping fluid through the prototype tools to test both longevity and durability of bearings, and to measure the pressure drop through the tool. The mud used in flow tests was a standard oil based mud, with 18 per cent solids, and a lime content of 1.2 pounds per barrel. Flow tests, even with $CaCO_3$ laden mud systems demonstrated that the tool would not suffer erosion, but the flow tests also showed that the major design issue at that stage was thrust bearing wear. An engineering action plan was launched to remedy the bearing design.

Dynamometer tests (Fig. 8) were also carried out in a similar fashion, but with water as operating fluid, to check that CFD estimates of torque, rotational speed and pressure drop matched the real figures. Early results proved that within 10 per cent the CFD estimations on torque were reliable. A typical output plot of torque, rpm and flow is given in Fig. 9.

Drill through tests, performed on a small land rig (Fig. 10), demonstrated that drilling rates of 2cm per minute, well within the target limits, were achievable. The dummy turbine shown (Fig. 11) is an example of models that were used for practical testing. Drill cuttings were gathered to look at the form of the cutting, which varied with cutting speed and temperature (Fig. 12). Material is one factor, but better results were also obtained where the material was discontinuous or contained designed upsets such as in the rotor blades. The early prototype was made with a composition of materials, primarily aluminium, and the obvious concern was the effect of drill bit smearing the heated aluminium and reducing the cutting efficiency. A second engineering plan was launched to improve drillability.

The high speed proposal was coupled with a reamer shoe possessing commercial PCD inserts with small diameter. The small diameter was selected to produce ideally small cuttings while reaming, to improve the capacity of the circulation system to carry debris and fines back to surface. Fluid mechanics studies had been performed with various centralizer systems to understand which blade configurations actually create turbulence to lift and keep cuttings in the flow stream.

## 6. Running Casing Tubulars

The commercial tools are best described as drillable independently powered casing reaming systems. The selected power system is based on modified turbine technology. Turbine technology was introduced by the Russians (Tiraposky et al) as early as the 1930s, and

> The mechanics of completing very long horizontal wells dictates the use of lighter weight low torque liner systems, so even in the more simple cases, it is not possible to treat the equipment in the same manner as drilling equipment.

many configurations were proposed over the years. Turbine technology provides high speed, low torque performance which is ideal for reaming. Other features of turbine technology include perfect dynamic balance, low pressure drop across the device, and the absence of elastomers, which allows turbine technology to work at high temperatures and also with any drilling fluid chemistry. Another less obvious feature is the pressure telltale or signal at surface which, upon motor stall, goes down. These remarkable attributes have been enhanced and will be discussed later.

An area that required significant attention was the drill through time. A very significant effort was made in this area and the results are quite remarkable. By the use of the right materials and by placing more and more of the motor outside the path of the drill though bore, the drill through time has been reduced to a few minutes. Through this elegant solution, after cementing, it remains only necessary to drill the cement in the shoe track and the through the reamer bit. It should be mentioned at this point that following the reaming process, the cementation is also carried out in the normal manner; cement accessories such as float collars are run above the tool, and the cement is pumped through the tool.

Several tools have been built to date, in various common sizes. On average the tools have a length up to 16 ft, allowing dog leg severity tolerance of approximately 14 degrees. The construction is of standard casing grade steel or higher, and thus compatible with any string design. Three engineering peer reviews were conducted during the design phase. The industry standard "fit for purpose" benchmark was successfully concluded through an operator-funded independent Detailed Design Review.

### 7. Running Completion Tubulars

Based on the development of the above technology, it was evident that the modified turbine power source may support the running of completions. The aim was to design a tool that was completion compatible, and designed specifically for completion placement. The objective was to wash and ream a given borehole section, re-establish the borehole condition, and allow the safe passage of the completion without the need for rotation.

> "Drilling motors can introduce vibration damage, reactive torque at low speeds, necessarily high operating pressures and circulating rates, and pressure spikes which can trigger hydraulically actuated components in the completion string"

Completion technologies, in line with all oilfield technology, have continuously evolved. The level of sophistication of completions has increased to meet both the drainage strategy of the operator and the required life-of-well reliability. There is a greater focus on completion technology, whether cased-hole functionality, sand control, production monitoring or inflow performance management. Completion control technology provides the ability to selectively produce from and inject into specific zones to improve reservoir and field management. Hydraulic control lines, fibre optic cables, intelligent well mandrels, screen systems and permanent monitoring completions are essentially non rotatable. The benefits of these more delicate sensing systems are obvious, but the ability to rotate the completion string is gone. The mechanics of completing very long horizontal wells dictates the use of lighter weight low torque liner systems, so even in the more simple cases, it is not possible to treat the equipment in the same manner as drilling equipment.

To add to these challenges, many of these sophisticated completions will be placed in long horizontal well applications in semi depleted fields, where the mechanical integrity of the formation is reduced, leading to borehole instability. This is no longer the environment to deploy conventional approaches.

To summarise the design objectives, it was established that the tool must work with all completion systems and in particular all sizes, particularly where swellable packers approach the size of the borehole. The tool must provide reaming, but as in the case of the drillable systems, not introduce any risk to the completion string, or the formation.

The use of motors is not a new concept in completion placement. However, using drilling motors such as Positive Displacement Motors (PDM) may add associated risks to the overall completion operations. Drilling motors can introduce vibration damage, reactive torque at low speeds, necessarily high operating pressures and circulating rates, and pressure spikes which can trigger hydraulically actuated components in the completion string. Additionally, the weight on bit required to effect a reaming action, and the ability of the tool to side track inadvertently add to the risks when combining drilling technology within the constraints of new advanced completion systems.

The same approach to engineering design was adopted. The initial goals were set to provide reaming time for at least 20 hours, a torque capacity of 1000 ft-lbs with a high speed reaming action of up to 800rpm. Prototype tools, with a maximum design length of 5 metres, were tested. The inherent properties of the turbine fitted the requirements very well, namely low torque, low reactive torque, low vibration, low pressure drop, the absence of elastomers, and importantly, the pressure response at stall.

The turbine technology can deliver rotational speeds from 600rpm under load to 1500 rpm under no load conditions with a very low pressure drop through the tool. The operating flow rate can be as low as 2 barrels per minute with a 200psi pressure drop, thus ensuring compatibility with low flow rate components. The same operating window allows safe management of circulating pressure to avoid formation damage. By varying the number of stages in the tool, and/or by varying the actual shape of the rotors and stator blades, the pressure drop across the tool can be tailored for a known hydraulic situation. In this way the effective circulation density (ECD) can be managed.

There are low frictional losses within the tool from a bearing system that can absorb considerable thrust loads, improved from the earlier work. With average completion fluid weights, the system will deliver 700–1000 ft-lb of torque, adequate for reaming but well under the torque makeup figures for even lightweight couplings. Furthermore, the fluid drive will prevent sudden impulses of reactive torque. As mentioned above, taking advantage of an inherent characteristic of turbine systems provides an important operational feature. When the reamer stalls, the circulating pressure reduces, providing both a telltale at surface and the required protection for any downhole component such as a hydraulically set liner hanger. To highlight the absence of vibrations, tools have been tested to free run speeds of 1500rpm and higher without noticeable vibration to the hand. This certainly is a suitable technology to avoid vibration damage to completions, but, as can be appreciated, it has been necessary to dynamically balance all reamer shoes to match this performance.

## 8. Case Histories

The new reaming systems have been used in the North Sea. One example required the drilling of an 8½″ horizontal drain, then running 3000ft of 7⅝″ pre drilled liner to 8700ft MD. There were significant difficulties on the first attempt to run the liner, the root cause being bore hole instability. After sidetracking the abandoned well, a larger diameter 9½″ horizontal drain was prepared for the pre-drilled liner. String rotation was prohibited because of the limited torsional yield strength of the flush joint connections being used. Other motors were not considered due to the risk of a pressure spike on stalling or starting, which could prematurely set the liner. Due to the relatively low fracture gradient in the reservoir it was not possible to increase mud weight further due to the risk of losses and well impairment.

The reaming system was deployed and was successful to re-establish 3000ft of open hole, accessing 1750ft of net pay. A combination of reaming, reciprocation and circulation were used to get the string to bottom over a 12-hour period. The end of well report concluded that the optimal procedure would have been to drill from the start an 8½″ standard hole and run the 7⅝″ completion with the new system.

In another example, the equipment was deployed to successfully land 5500ft of 4.5″ liner into a 6″ open hole, which was subsequently cemented in place. The cementing operation through the power section and reamer shoe proceeded normally.

## 9. Conclusions

The conclusions are straightforward:

- The application of established motor technology to address a new challenge was successful.
- A drillable motor system was developed through practical design and testing of materials.
- Through design, the need to drill through the motor has been eliminated.
- Field deployment of the reaming system has been successful.

# Proactive Scale Mitigation Strategies for Simple to Complex Multilateral Producers in a Saudi Arabian Carbonate Field

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## Abstract
Calcium carbonate ($CaCO_3$) is the most predominant scale in Saudi Aramco crude producers. Conventional phosphonate based scale inhibitor treatments are highly effective in carbonate formations. Application of new research findings in the company's modified scale inhibitor squeeze treatment programs has significantly improved the treatment life at the lowest possible cost. These modifications resulted in better post-squeeze well response compared to more conventional treatment. Although, in spite of the success of scale inhibitor treatment in vertical and conventional horizontal wells, addressing the placement of chemicals in long horizontal and complex producers, such as multilateral, maximum reservoir contact (MRC) and extreme reservoir contact (ERC) wells is always challenging and cost intensive.

A drop in operating pressure at a gas-oil separation plant (GOSP) from 450 psig to 250 psig in a carbonate field necessitated a proactive scale inhibitor treatment program. A comprehensive scale mitigation study was conducted to prioritize the treatments based on the severity of the scaling potential for all the vertical, deviated, horizontal, multilateral, and MRC wells as part of the company's scale mitigation strategy. Conventional bullheading of chemicals from the surface into all laterals and selective lateral treatment after comprehensive lateral testing was executed as part of the trial test campaign. This article describes/illustrates well selection criteria for priority treatment methods applied for simple to complex wells, comparison of pre- and post-production results, and a discussion of the current ongoing optimization program.

Fig. 1. Severity of CaCO3 scaling in the Ghawar field before scale inhibitor treatments.

## Introduction
Oil and gas production generally contains water that under some conditions can lead to mineral scale deposition, such as calcium carbonate ($CaCO_3$) and sulfates of calcium, strontium and barium[1]. This scaling impairs fluid flow, and can lead to plugging of tubing, valves, and surface equipment, Fig. 1. When these scales affect well productivity or facility integrity, it is necessary to remove these scales and/or adopt an effective scale mitigation strategy.

The formation of oil field scale, in particular, $CaCO_3$, is recognized as one of the major problems associated with oil and gas production in Saudi Aramco[2-4]. Until the late 1980s, scaling was considered a serious threat to Ghawar field production due to an underdeveloped scale mitigation strategy. Consequently, since the first scale inhibitor squeeze in 1987, $CaCO_3$ scale mitigation for the Ghawar field producers has been very successful. As a result, scale mitigation is considered a routine simple job in the Ghawar field, although it is a challenge for complex wells, Fig. 2.

Abqaiq field, a carbonate formation in the south, produces Arab Extra Light crude with an aquifer waterflood support. Its reservoir, formation, and produced fluid properties are very similar to the Ghawar field. Gas-oil separation plant (GOSP) operating pressures in the Ghawar field are less than 200 psig and most of the producers have $CaCO_3$ scaling potential. Consequently, scale inhibitor treatment has been the norm for wet producers to prevent scaling problems in the Ghawar field. Almost all untreated wet producers in the early 1990s showed $CaCO_3$ scaling tendencies once the well became wet. In addition, scale inhibitor treatment life in the carbonate field is notably long (more than 5 to 10 years) compared to less than a year in other parts of the world. Coupled with the above observations, the norm for scale control in the Ghawar producers is to treat once a well becomes wet or has measurable water cut (about 5% to 10%).

Until recently, scaling problems were not a concern in Abqaiq field. The absence of any scaling problems for Abqaiq field producers was attributed to its high operating pressure in the GOSPs (450 psig). In fact, this observation was used to an advantage in other fields by installing a choke to maintain higher upstream pressure to avoid scaling in the production tubing. Subsequently, this strategy may result in $CaCO_3$ scaling downstream of the choke where the pressure drop is high. Operating pressure in GOSP-C of Abqaiq field was reduced from 450 psig to 250 psig in the second

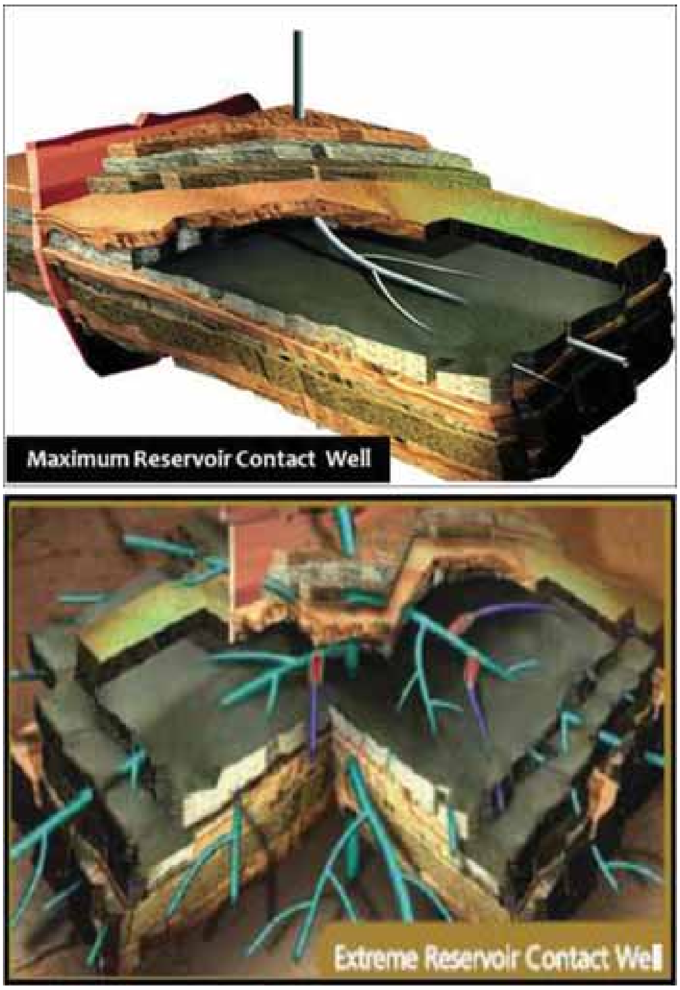


Fig. 2. Diagrams of complex wells.

| Well # | Na* | Ca | Sr* | Mg | SO4 | Cl | $HCO_3$ | TDS | pH | Sp. Grav. |
|---|---|---|---|---|---|---|---|---|---|---|
| Well-EA | 20,700 | 6,070 | 304 | 819 | 767 | 45,700 | 275 | 74,635 | 7.00 | 1.0563 |
| Well-EC | 8,808 | 2,740 | 137 | 457 | 634 | 19,100 | 343 | 32,219 | 7.10 | 1.0251 |
| Well-FC | 29,300 | 9,260 | 463 | 1,170 | 506 | 64,400 | 266 | 105,365 | 6.10 | 1.0787 |
| Well-FD | 46,000 | 12,900 | **710** | 1,640 | 506 | 98,000 | 414 | 160,170 | 6.30 | 1.1091 |
| Well-FE | 40,300 | 10,700 | | 1,360 | 493 | 84,400 | 383 | 137,636 | 6.90 | 1.0975 |
| Well-GO | 13,500 | 3,280 | 164 | 455 | 815 | 27,200 | 246 | 45,660 | 7.70 | 1.0330 |
| Well-GC | 48,800 | 14,700 | 735 | 1,760 | 383 | 106,000 | 168 | 172,546 | 6.10 | 1.1250 |
| Well-GE | 35,400 | 11,000 | 550 | 1,320 | 392 | 77,300 | 493 | 126,455 | 6.40 | 1.0913 |
| Well-HD | 41,500 | 16,200 | | 1,410 | 485 | 88,300 | 165 | 143,560 | 6.6 | 1.0912 |
| Well-HE | 50,100 | 13,600 | 680 | 1,730 | 375 | 106,000 | 277 | 172,762 | 6.60 | 1.1203 |
| Well-HF | 26,700 | 8,480 | 424 | 1,020 | 433 | 58,800 | 280 | 95,937 | 7.20 | 1.0724 |
| Well-AOO | 66,400 | 16,200 | | 2,070 | 115 | 137,000 | 101 | 221,886 | 6.20 | 1.1575 |
| Well-AOF | 20,300 | 5,700 | 285 | 787 | 574 | 43,100 | 256 | 71,002 | 7.10 | 1.0520 |
| Well-AAO | 19,400 | 5,160 | 258 | 700 | 345 | 40,600 | 341 | 66,804 | 6.50 | 1.0486 |
| Well-AAA | 20,600 | 6,970 | 349 | 855 | 459 | 46,100 | 382 | 75,715 | 7.60 | 1.0574 |
| Well-AAC | 24,000 | 8,710 | 436 | 1,150 | 562 | 59,500 | 191 | 94,549 | 6.90 | 1.0711 |
| Well-AAE | 27,100 | 7,540 | 377 | 1,080 | 543 | 57,700 | 243 | 94,583 | 7.20 | 1.0675 |
| Well-AHA | 20,300 | 5,780 | 289 | 837 | 534 | 43,500 | 252 | 71,492 | 6.80 | 1.0531 |
| Well-BDO | 47,100 | 13,100 | **700** | 1,540 | 351 | 100,000 | 166 | 162,957 | 5.90 | 1.1138 |
| Well-BFF | 33,600 | 8,940 | 447 | 1,020 | 612 | 70,100 | 139 | 114,858 | 6.50 | 1.0805 |
| Well-BHD | 27,500 | 7,640 | | 932 | 420 | 58,200 | 133 | 94,825 | 6.80 | 1.0693 |
| Well-BHF | 56,500 | 17,200 | | 1,970 | 212 | 123,000 | 191 | 199,073 | 6.10 | 1.1423 |
| Well-BIH | 60,000 | 16,600 | 830 | 1,860 | 291 | 127,000 | 187 | 206,768 | 6.30 | 1.1386 |
| Well-COC | 16,400 | 4,530 | **250** | 595 | 553 | 34,500 | 345 | 57,173 | 6.40 | 1.0414 |
| Well-COH | 12,200 | 3,490 | 175 | 513 | 623 | 25,800 | 285 | 43,086 | 7.20 | 1.0343 |
| Well-CCD | 23,300 | 9,290 | 465 | 1,130 | 687 | 54,900 | 478 | 90,250 | 7.20 | 1.0691 |
| Well-CCH | 24,100 | 7,860 | 393 | 990 | 429 | 53,400 | 314 | 87,486 | 6.80 | 1.0637 |
| Well-CCI | 13,000 | 3,330 | **150** | 434 | 832 | 26,500 | 247 | 44,493 | 6.90 | 1.0327 |
| Well-CDO | 12,700 | 3,650 | 183 | 501 | 1,250 | 26,500 | 243 | 45,027 | 7.30 | 1.0277 |
| Well-CDA | 5,589 | 911 | 46 | 158 | 1,000 | 9,690 | 458 | 17,852 | 7.70 | 1.0128 |
| Well-CDB | 17,800 | 5,630 | 282 | 710 | 587 | 39,000 | 159 | 64,168 | 7.00 | 1.0476 |
| Well-CFC | 4,214 | 1,410 | 71 | 215 | 488 | 9,120 | 243 | 15,761 | 7.10 | 1.0131 |
| Well-CGG | 6,224 | 1,840 | 92 | 273 | 465 | 13,100 | 359 | 22,353 | 7.40 | 1.0171 |
| Well-CGH | 16,000 | 3,720 | | 530 | 520 | 33,980 | 300 | 56,300 | 6.6 | 1.0410 |
| Well-CHG | 70,200 | 21,400 | 1,070 | 2,330 | 190 | 152,670 | 119 | 247,979 | 5.90 | 1.1703 |
| Well-DAA | 37,800 | 10,400 | 520 | 1,230 | 508 | 79,900 | 100 | 130,458 | 6.30 | 1.0923 |
| Well-DAI | 16,100 | 5,490 | 275 | 741 | 727 | 36,000 | 225 | 59,558 | 6.90 | 1.0432 |
| Well-DBO | 17,500 | 5,280 | 264 | 679 | 482 | 37,900 | 154 | 62,259 | 6.60 | 1.0457 |
| Well-DBB | 38,500 | 12,000 | 600 | 1,420 | 307 | 84,500 | 111 | 137,438 | 6.10 | 1.0965 |
| Well-DGC | 36,400 | 12,900 | **760** | 1,650 | 370 | 83,400 | 120 | 134,840 | 6.70 | 1.0974 |
| Well-DGD | 11,800 | 2,250 | 113 | 340 | 674 | 22,500 | 255 | 37,932 | 7.00 | 1.0273 |
| Well-DGE | 10,800 | 3,020 | 151 | 402 | 1,640 | 21,900 | 165 | 38,078 | 8.00 | 1.0098 |
| Well-DGF | 29,700 | 7,800 | 390 | 1,050 | 582 | 62,100 | 227 | 101,849 | 6.30 | 1.0752 |
| Well-EOE | 8,031 | 2,120 | **96** | 289 | 412 | 16,500 | 307 | 27659 | 7.50 | 1.0196 |

**Table 1. Formation water composition for oil producers**

> Until the late 1980s, scaling was considered a serious threat to Ghawar field production due to an underdeveloped scale mitigation strategy.

half of 2008. Therefore, GOSP-C area producers are anticipated to have $CaCO_3$ scaling due to lowering of the operating pressure.

Abqaiq field produces from a number of vertical, deviated, simple horizontal, multilateral and smart multilateral (SML) wells perforated from as low as 5 ft (vertical) to as high as over 18,000 ft (open hole multilaterals). Its average porosity is 18.5%. A majority of these producers are restricted with chokes to maintain the flowing wellhead pressure at about 450 psig. The range of water cut varies between 0% to 94% with a gas-oil ratio (GOR) between 342 standard cubic ft (scf)/ Stock Tank Barrel (STB) to 1,276 scf/STB. The shut-in bottom-hole temperature (SBHT) varies between 214°F to 235°F, with an average of 224°F (106.7°C), as calculated from the latest temperature survey index reports. Similarly, the shut-in bottom-hole pressure (SBHP) varies between 2,707 psig to 3,364 psig, with an average of 3,080 psig, as calculated from the bottom-hole pressure survey data. Average carbon dioxide (CO2) and hydrogen sulfide (H2S) content in the gas phase of the GOSP feed are 5.3 mol% and 2.5 mol%, respectively.

## Geochemical Composition

All the producers are from the Arab-D reservoir. The total dissolved solids (TDS) of brines vary significantly, with the lowest being 15,761 mg/L and the highest being 247,979 mg/L. Calcium ion concentrations are in the range of 911 mg/L to 21,400 mg/L. Sulfate ion concentration varies from 190 mg/L to 1,640 mg/L. The well database does not contain other trace metals, such as strontium and barium, in the geochem analysis. Although, the concentration ratio (in mg/L) for Sr/Ca varies between 0.043 and 0.055, with an average of 0.050, for seven recently collected (November 2007) produced water samples from Abqaiq field. Therefore, a value of 0.050 was used to estimate strontium ion concentration based on the calcium ion concentration for the other GOSP-C producers. Alkalinity ($HCO_3^-$) values were corrected based on earlier geochem data for Well-HF, to Well-DAA and Well-DGE mg/L. Validated geochemical data of some produced waters are given in Table 1.

## Scaling Potentials

$CaCO_3$ is the most commonly encountered scale in Saudi carbonate fields. The presence of high reservoir pressure (>3,000 psig) combined with 5% to 20% dissolved acid gas ($CO_2$ and $H_2S$), means there is no $CaCO_3$ scaling problem in the reservoir and at the bottom of the tubing; however, as the fluid moves up the production tubing, pressure decreases and the dissolved gases flash out of the fluid. The loss of $CO_2$ and $H_2S$ results in an increase in fluid pH, and shifts the thermo-dynamic balance toward super saturation of the pro-duced water with respect to $CaCO_3$. By the time the nucleation and kinetics of crystal growth favor scale formation, the brine will have reached the top

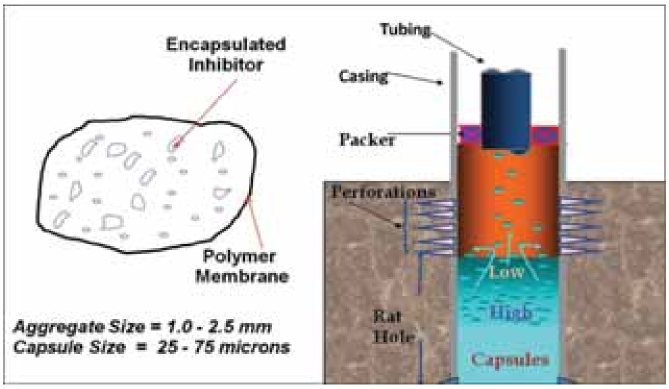


Fig. 3. Encapsulated scale inhibitor treatment.

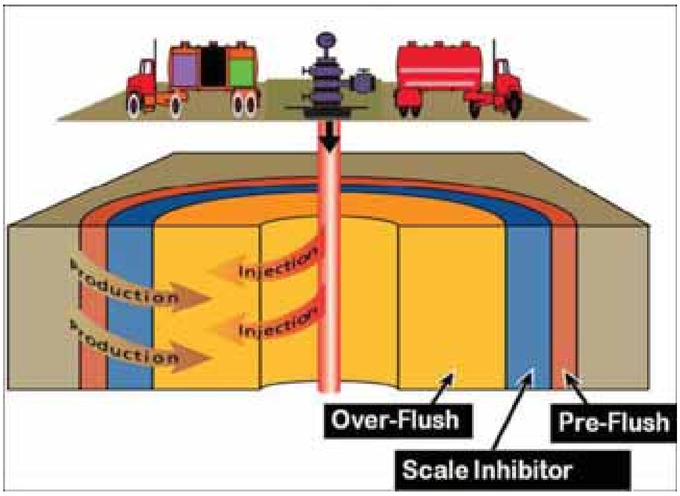


Fig. 4. Drawing of scale inhibitor squeeze.

1,000 ft or higher of the production tubing. $CaCO_3$ scale formation is represented by the equation:

$$Ca^{2+} + 2HCO_3^- \leftrightarrow CaCO_3\,(s) + H_2O + CO_2 \qquad (1)$$

Sulfate scale formation is represented by the equation:

$$M^{2+} + SO_4^{=} \leftrightarrow MSO_4\,(s) \qquad (2)$$

where $M^{2+}$ corresponds to $Ca^{2+}/Sr^{2+}/Ba^{2+}$. An increase in temperature and/or decrease in pressure will increase $CaCO_3$ and $CaSO_4$ scaling severity.

Scale prediction programs from Rice University (ScaleSoftPitzer – SSP) and the University of Oklahoma (OKSCALE) are used to predict scaling tendencies of produced brines[5, 6]. OKSCALE results were optimized based on its usage with other carbonate field operations. The OKSCALE computed saturation indices (SI) and scale amounts in mg/L (SA) at producing wellhead temperature and pressure conditions were computed for all wet wells. The GOSP-C producers are classified as high, moderate, low, or no scaling potential based on the predicted SI and SA.

All producers have $CaCO_3$ scaling potential. The SI values for sulfates of calcium and strontium are either negative or very low indicating that the produced brines are under saturated and/or have very low potential for sulfate scaling. Only two wells have low $CaSO_4$ scaling potential, but a majority of the wells have low $SrSO_4$ potential (based on estimated strontium ion concentrations); however, phosphonate based scale inhibitor treatments conducted for $CaCO_3$ scale mitigation effectively control sulfate scale as well. GOSP-C producers are prioritized for scale inhibitor treatment based on the severity of their scaling potential.

> "Once oil production is resumed, convection, solubility, and diffusion processes result in a release of inhibitor into the produced fluids with subsequent scale inhibition."

## Scale Inhibitor Treatments

Successful scale mitigation treatment strategies applied in the Ghawar field can also be applicable in Abqaiq field due to their production and operation similarities.

Low MIC: After monitoring residual returns of many Scale Inhibitor Squeeze (SIS) and encapsulate treated wells in Ghawar field and other carbonate fields, it was concluded that the minimum inhibitor concentration (MIC) required for $CaCO_3$ scale mitigation is very low, 0.1 mg/L (chemical as analyzed for organic phos-phonate, which is equivalent to 0.5 mg/L of as-received organic phosphonate). This is the minimum detection limit for phosphonate scale inhibitor in our laboratory. It is highly probable that the actual inhibitor concentration is lower than 0.1 mg/L. Consequently, the MIC for carbonate formations is believed to be less than 0.1 mg/L of the inhibitor chemical (organic phosphonate) as analyzed. It is also reasonable to suggest that the MIC for Abqaiq field might also be below 0.1 mg/L.

Two types of scale inhibitor treatments are common for the producers in Saudi Aramco: 1) encapsulated, and 2) SIS.

**Encapsulated Chemical Treatment**

An encapsulated scale inhibitor treatment is limited to those wells with a rat hole, and it is not viable for open hole, horizontal, multilateral, or maximum reservoir contact (MRC) wells. The liquid scale inhibitor is coated with a polymer membrane, which allows the chemical to diffuse slowly into the surrounding brine. The capsules can be bullheaded into the well, where they settle in the rat hole below the producing zone (specific gravity of ~ 1.5 $g/cm^3$). Diffusion equilibrium is established between the encapsulated chemical and the brine in the rat hole. Once oil production is resumed, convection, solubility, and diffusion processes result in a release of inhibitor into the produced fluids with subsequent scale inhibition[7-9]. A schematic of an encapsulated chemical treatment procedure for wells with rat holes is shown in Fig. 3. The encapsulated treatment is simple to perform and less expensive; under $10,000/ well. The effective treatment life is limited by rat hole depth, water cut, and water production rate; however, there should not be any communication or flow from the bottom of the well, as the entire chemical can be lost in the first few hours of production.

Encapsulated scale inhibitor treatments were conducted for many carbonate field producers with rat hole depths of 100 ft to 300 ft; however, a well with the shortest rat hole depth (17 ft) had an encapsulated treatment that gave a treatment life over two years. An encapsulated treatment program was conducted for one well that has a rat hole in the GOSP-C area.

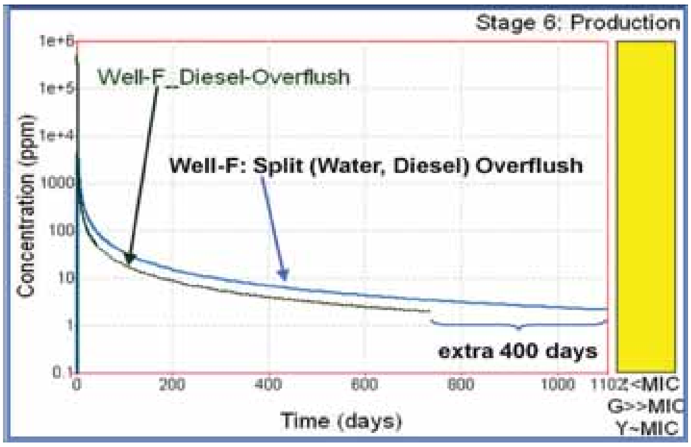


**Fig. 5. Effect of over flush on scale inhibitor squeeze life (MIC of 2 ppm) - comparing 100% diesel with split over flush of 25% water followed by 75% diesel.**

**Scale Inhibitor Squeeze**

SIS treatments can be applied for all producers, including wells with rat holes. Generally, a SIS treatment life is longer than an encapsulated treatment life.

The SIS involves injection of significant quantities of fluids in different stages into the formation with a shut-in period for the chemical to interact with the formation rock. Part of the chemical returns with produced water at a level greater than that required to prevent scale deposition[2, 10-13]. The time required for the residual inhibitor return to drop typically 1 ppm to 15 ppm; however, the MIC in the Ghawar field is lower than the inhibitor detection limit of 0.1 ppm. Squeeze life of six months to one year is common in the oil industry, with the shortest being 1-2 weeks for some severe scaling wells in the North Sea. In Saudi Arabia, the squeeze treatment program has been extremely successful for $CaCO_3$ scale mitigation in the carbonate fields with a squeeze life exceeding 10 years. A schematic of the squeeze treatment program is shown in Fig. 4.

A typical SIS treatment consists mainly of two stages: 1) Pumping fluids, and 2) Shut-in period. The pumped fluids contain multistages, the first being a preflush of low saline fresh water with a surfactant. The function of the preflush is to reduce the concentration of precipitating calcium ions (with inhibitor) near the wellbore area and to clean up the formation rock to improve inhibitor rock interactions. Scale inhibitor is the second stage of pumped fluid. Generally, a (tri- or penta-) phosphonate based scale inhibitor is preferred for $CaCO_3$/$CaSO_4$ scale mitigation in Saudi Aramco. In the third stage, a significant quantity of water or diesel as overflush is then pumped to push the inhibitor away from the wellbore area, into the formation. Finally, the production tubing is filled with diesel to minimize corrosion problems during the shut-in period. After completing all the pumping stages, the well will be shut down for 1–4 days so that the inhibitor can interact and react with the carbonate based formation rock. An insufficient shut-in period may result in excessive inhibitor return and shorter treatment life.

The normal parameters in a conventional squeeze are:

• Treatment radius: 3 ft to 10 ft from the wellbore.
• 100 bbl to 2,000 bbl of 5% to 50% inhibitor.
• Residual returns above MIC (MIC < 0.1 ppm in Saudi Aramco).
• Residual return should stay above the MIC for the period of squeeze life, typically 5–10 years in the Ghawar field.

The average cost for SIS treatment in the Ghawar field is less than $15,000 per well; however, it can be over $200 M for many North Sea producers and over $1 MM if coiled tubing (CT) is required. The estimated cost was over $150 M for CT usage in some offshore Saudi wells; however, bullhead treatment for the SIS jobs was adopted success- fully with significantly lower cost.

*Horizontal Wells:* Due to their long length of producing contact with the pay zone, horizontal wells give substantial increased productivity and increased sweep factor per well. There is extensive published literature on horizontal well production operations, but limited information is available on mineral scaling problems or case histories of horizontal well scale mitigation.

| Well # | | Preflush | SI (50% diluted) | Spacer | Overflush | Displacement |
|---|---|---|---|---|---|---|
| Well-EA | | 15.4 | 48.1 | 73.1 | 169.9 | 114 |
| Well-EC | | 15.4 | 54.1 | 15.3 | 6.8 | 30 |
| Well-FC | | 15.4 | 72.1 | 91.9 | 225.2 | 118 |
| Well-FD | | 31.1 | 96.2 | 132.7 | 300.4 | 81 |
| Well-FE | | 15.4 | 48.2 | 69.0 | 158.1 | 101 |
| Well-GO | | 30.8 | 96.4 | 149.0 | 348.2 | 114 |
| Well-GC | | 15.4 | 72.1 | 15.3 | 279.2 | 121 |
| Well-GE | | 15.4 | 48.1 | 45.2 | 87.9 | 117 |
| Well-HD | | 15.4 | 48.2 | 35.0 | 58.1 | 73 |
| Well-HE | | 15.4 | 48.1 | 64.3 | 144.2 | 119 |
| Well-HF | | 15.4 | 72.1 | 29.4 | 415 | 233 |
| Well-AOO | | 15.4 | 48.2 | 81.1 | 193.6 | 160 |
| Well-AOF | | 15.4 | 52.9 | 86.5 | 209.4 | 123 |
| Well-AAO | | 15.4 | 72.1 | 67.7 | 154.1 | 115 |
| Well-AAA | | 15.4 | 48.1 | 54.2 | 114.4 | 51 |
| Well-AAC | | 15.4 | 48.1 | 65.5 | 147.5 | 42 |
| Well-AAE | | 30.8 | 96.2 | 149.0 | 348.2 | 88 |
| Well-AHA | | 15.4 | 50.7 | 67.7 | 154.1 | 125 |
| Well-BDO | | 30.8 | 96.4 | 149.0 | 348.2 | 117 |
| Well-BFF | | 30.8 | 120.5 | 165.2 | 395.9 | 207 |
| Well-BHD | | 15.4 | 72.1 | 81.1 | 193.6 | 233 |
| Well-BHF | | 15.4 | 72.3 | 77.1 | 181.8 | 230 |
| Well-BIH | | 15.4 | 72.1 | 67.7 | 154.1 | 131 |
| Well-COC | | 30.8 | 96.2 | 132.7 | 300.4 | 121 |
| Well-COH | | 30.8 | 96.4 | 152.2 | 357.7 | 90 |
| Well-CCD | | 15.4 | 72.1 | 94.6 | 233.1 | 129 |
| Well-CCH | | 15.4 | 72.1 | 73.1 | 169.9 | 131 |
| Well-CCI | | 15.4 | 48.2 | 108.0 | 272.7 | 309 |
| Well-CDO | | 20.5 | 72.1 | 39.7 | 56.9 | 133 |
| Well-CDA | | 15.4 | 56.2 | 39.6 | 71.3 | 113 |
| Well-CDB | | (Encapsulated Treatment) | | | | |
| Well-CFC | | 30.8 | 96.4 | 155.5 | 367.3 | 186 |
| Well-CGG | | 30.8 | 96.4 | 149.0 | 348.2 | 186 |
| Well-CGH | | 30.8 | 96.4 | 132.7 | 300.4 | 224 |
| Well-CHE | | 30.8 | 96.4 | 132.7 | 300.4 | 278 |
| Well-CHG | | 31.1 | 96.4 | 149.0 | 348.2 | 267 |
| Well-DAA | | 30.8 | 96.2 | 147.7 | 344.4 | 198 |
| Well-DAI | | 30.8 | 96.2 | 132.7 | 300.4 | 212 |
| Well-DBO | | 30.8 | 96.4 | 136.0 | 310.0 | 109 |
| Well-DBB | | 30.8 | 96.4 | 142.5 | 329.1 | 153 |
| Well-DGC | | 65.1 | 150.6 | 181.4 | 443.7 | 384 |
| Well-DGD | | 30.8 | 150.6 | 181.4 | 443.7 | 533 |
| Well-DGE (L3) | | 56.3 | 96.4 | 181.4 | 443.7 | 149 |
| Well-DGF (L3) | | 57.9 | 96.4 | 181.4 | 443.7 | 145 |
| Well-EOE | (L2) | 48.8 | 96.4 | 165.2 | 395.9 | |
| | (L4) | 61.5 | 96.4 | 149.0 | 348.2 | 173 |

**Table 2. SIS treatment details (All volumes are in bbl)**

| Well # | Laterals | ICV | KOP (ft) | TD (ft) | Open Hole (ft) | Oil Rate (BPD) | WC (%) | FBHP (psi) | SBHP (psi) | ICV Status | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|
| DGC | L4 (Topmost) | ICV4 | 8,135 | 11,707 | 3,572 | NA | NA | NA | NA | ICV4 Fully Open | ICV Malfunctioned |
| | L3 | ICV3 | 9,127 | 12,148 | 3,021 | NA | NA | NA | NA | ICV3 Fully Open | |
| | L2 | ICV2 | 10,139 | 13,371 | 3,232 | NA | NA | NA | NA | ICV2 Fully Open | |
| | L1 | ICV1 | 10,751 | 14,086 | 3,335 | NA | NA | NA | NA | ICV1 Fully Open | |
| | MB (Bottom) | | 11,264 | 12,203 | 939 | NA | NA | NA | NA | | |
| | All | Total Open Hole Length | | | 14,099 | 7,044 | 12.2 | 3,110 | 3,155 | | |
| DGD | L4 (Topmost) | No ICV | 8,135 | 10,879 | 2,744 | NA | NA | NA | NA | | No ICV |
| | L3 | No ICV | 9,214 | 16,100 | 6,886 | NA | NA | NA | NA | | |
| | L2 | No ICV | 10,320 | 12,950 | 2,630 | NA | NA | NA | NA | | |
| | L1 | No ICV | 11,202 | 16,005 | 4,803 | NA | NA | NA | NA | | |
| | MB (Bottom) | No ICV | 12,950 | 14,473 | 1,523 | NA | NA | NA | NA | | |
| | All | Total Open Hole Length | | | 18,586 | 4,218 | 52 | | 3,150 | | |
| DGE | L3 (Topmost) | ICV4 | 8,000 | 12,981 | 4,981 | NA | 2.6 | 2,822 | 3,190 | ICV4 Fully Open | SML |
| | L2 | ICV3 | 10,187 | 14,500 | 4,313 | NA | 17 | 2,765 | 3,194 | ICV3 Fully Open | |
| | L1 | ICV2 | 10,807 | 13,750 | 2,943 | NA | 2.9 | 2,783 | 3,198 | ICV2 Fully Open | |
| | MB (Bottom) | ICV1 | 10,998 | 12,000 | 1,002 | NA | 3.04 | 2,603 | 3,164 | ICV1 Fully Open | |
| | All | Total Open Hole Length | | | 13,239 | 1,963 | 50 | | | | |
| DGF | L3 (Topmost) | ICV4 | 8,097 | 10,000 | 1,903 | NA | 7.6 | 1,991 | NR | ICV 4 Fully Open | SML |
| | L2 | ICV3 | 8,850 | 11,760 | 2,910 | NA | 31 | 2,600 | NR | ICV3 Closed | |
| | L1 | ICV2 | 9,248 | 10,526 | 1,278 | NA | 0.9 | 1,905 | NR | ICV2 Fully Open | |
| | MB (Bottom) | ICV1 | 9,999 | 12,566 | 2,567 | NA | 65 | 2,724 | NR | ICV1 Closed | |
| | All | Total Open Hole Length | | | 8,658 | 3,025 | 23 | 2,217 | 3,162 | | |
| EOE | L4 (Topmost) | ICV4 | 7,974 | 11,779 | 3,805 | NA | 60 | 2,952 | 3,162 | ICV4 Fully Open | SML |
| | L3 | ICV3 | 8,785 | 12,241 | 3,456 | NA | 74 | 2,917 | 3,181 | ICV3 Fully Open | |
| | L2 | ICV2 | 9,899 | 14,120 | 4,221 | NA | 9.8 | 2,818 | 3,187 | ICV2 Fully Open | |
| | L1 | ICV1 | 10,833 | 14,699 | 3,866 | NA | 71 | 2,835 | 3,191 | ICV1 Fully Open | |
| | MB (Bottom) | | 11,397 | 12,565 | 1,168 | | | | | | |
| | All | Total Open Hole Length | | | 16,516 | 2,205 | 60 | 3,096 | 3,231 | All ICV Open | |

**Table 3. Multilateral and smart multilateral wells configuration and production data used for the modified SIS program**

> "When long horizontal, or highly deviated wells, produce from areas of high permeability contrast or with wellbore crossflow, expensive CT operations are required instead of bullhead operations."

**Squeeze Modeling**

Success for scale inhibitor treatment depends on the return of residual scale inhibitor during post-treatment production. Placement of the chemical is important and it must be placed predominantly into the current or expected water production zones to maximize treatment life. The location of scale formation in horizontal wells (critical for sulfate scales) and the MIC are important factors for chemical placement, which can be either in the "toe," "heel," "middle" or "all" sections. When long horizontal, or highly deviated wells, produce from areas of high permeability contrast or with wellbore crossflow, expensive CT operations are required instead of bullhead operations. As stated, the MIC for $CaCO_3$ scaling wells in Saudi Arabian carbonate fields is generally less than 0.1 ppm. Therefore, it was concluded[14] that at such low MIC, the location of chemical placement in the horizontal section is immaterial; whether the chemical stays in the heel, middle, toe, or all sections, the difference in squeeze life will be insignificant[3, 15]. There is no need to use expensive CT for spot treatment. Therefore, a simple and less expensive bullhead treatment was adopted successfully in these carbonate fields.

**Limitations of Conventional Squeeze**

Conventional squeeze treatments in Saudi Aramco carbonate formations are highly successful in mitigating $CaCO_3$ scale; however, the injection of large quantities of water into the near wellbore region may increase water saturation in the near wellbore region resulting in a loss of continuity of the oil phase. It can also alter the wettability in the near wellbore region. The time needed to reach the same production level as before treatment depends on the oil/water ratio, pressure drop, production rates, and rock properties. This is generally termed as "water block." In a worst case scenario, full return to pretreatment rates may not be achievable. In field operations, a significant drop in the productivity index was observed after squeezing several wells in the Ghawar field. In addition, it may be difficult to lift a column of water after a conventional SIS in wells with poor lifting energy, possibly requiring an expensive nitrogen liftoff procedure.

Alternatives to conventional squeeze treatment include the following:

1. Modified squeeze treatment with diesel as overflush.
2. Emulsified squeeze[16] (Scale inhibitor in a water-in-oil emulsion).

Modified bullhead squeeze treatments are successful in controlling $CaCO_3$ scale in the Ghawar field[17]. The primary changes include minimizing aqueous preflush and inhibitor phases, and replacing the typical aque-

| Well# | Pre-WC% | Post-WC% | Crude Rates: Post/Pre | Water Rates Post/Pre | Remarks |
|---|---|---|---|---|---|
| Well-EA | 64.8 | 73.1 | **1.04** | **1.54** | Perforated |
| Well-EC | 46 | 68.4 | **0.75** | **1.92** | Perforated |
| Well-FC | 57 | 61 | **1.38** | **1.63** | Open Hole |
| Well-FD | 8.6 | 10.1 | **0.61** | **0.73** | Open Hole |
| Well-FE | 60 | 57.3 | **1.12** | **1.00** | Perforated |
| Well-GO | 77.2 | 48 | **0.98** | **0.27** | Open Hole |
| Well-GC | 57.4 | 60 | **1.19** | **1.32** | Open Hole |
| Well-GE | 61 | 56.5 | **1.46** | **1.22** | Open Hole |
| Well-HD | 51.4 | 55.3 | **0.83** | **0.97** | Open Hole |
| Well-HE | 68.2 | 36.5 | **2.56** | **0.69** | Open Hole |
| Well-HF | 70.1 | 72 | **1.04** | **1.15** | Open Hole |
| Well-AOO | 82 | 75 | **1.50** | **0.99** | Open Hole |
| Well-AOF | 58.4 | 46.6 | **0.51** | **0.32** | Open Hole |
| Well-AAO | 82.1 | 86.2 | **1.18** | **1.61** | Open Hole |
| Well-AAA | 52 | 59 | **0.83** | **1.10** | Open Hole |
| Well-AAC | 32.4 | 19.8 | **1.34** | **0.69** | Open Hole |
| Well-AAE | 9.2 | 20.5 | **0.46** | **1.16** | Open Hole |
| Well-AHA | 66.3 | 19.8 | **1.83** | **0.23** | Open Hole |
| Well-BDO | 6.6 | 20 | **0.87** | **3.08** | Open Hole |
| Well-BFF | 94 | 84 | **0.91** | **0.30** | Open Hole |
| Well-BHD | 94 | 90 | **1.50** | **0.86** | Open Hole |
| Well-BHF | 77 | 83 | **0.63** | **0.91** | Open Hole |
| Well-BIH | 80 | 82 | **0.94** | **1.07** | Open Hole |
| Well-COC | 16.8 | 6.3 | **0.99** | **0.33** | Open Hole |
| Well-COH | 53 | 54 | **0.90** | **0.94** | Open Hole |
| Well-CCD | 65 | 77.3 | **1.39** | **2.56** | Open Hole |
| Well-CCH | 80 | 84 | **0.93** | **1.22** | Open Hole |
| Well-CCI | 0.2 | 30.8 | **1.27** | **281.32** | Open Hole |
| Well-CDO | 78.8 | 21.2 | **1.05** | **0.08** | Open Hole |
| Well-CDA | 54.9 | 53.1 | **0.96** | **0.89** | Open Hole |
| Well-CDB | 67 | 66 | **1.87** | **1.78** | Perforated |
| Well-CFC | 59.3 | 60.2 | **1.24** | **1.29** | Open Hole |
| Well-CGG | 40.7 | 60.2 | **0.86** | **1.89** | Open Hole |
| Well-CGH | 30 | 19 | **1.82** | **1.00** | Open Hole |
| Well-CHG | 0.2 | 0.2 | **0.86** | **0.86** | Open Hole |
| Well-DAA | 61.6 | 56.2 | **1.26** | **1.01** | Open Hole |
| Well-DAI | 20.5 | 6.0 | **1.27** | **0.31** | Open Hole |
| Well-DBO | 51.6 | 62.2 | **1.18** | **1.82** | Open Hole |
| Well-DBB | 55.6 | 63.2 | **0.96** | **1.32** | Open Hole |
| Well-DGC | 20.6 | 15 | **1.00** | **0.68** | Open Hole |
| Well-DGD | 54.7 | 62 | **0.81** | **1.09** | Open Hole |
| Well-DGE | 60.1 | 58.5 | **1.11** | **1.04** | Open Hole |
| Well-DGF | 34.4 | 33.9 | **1.12** | **1.10** | Open Hole |
| Well-EOE | 59 | 65.8 | **1.00** | **1.34** | Open Hole |
| **Total Production Ratio: Post/Pre SIS** | | | **1.05** | **1.05** | |

**Table 4. Effect of modified SIS on crude and water production rates**

> An emulsified squeeze treatment procedure has several advantages over conventional squeeze methods, especially for water sensitive formations and wells with poor reservoir support.

ous overflush with diesel, (lifting the well easier after treatment).

An emulsified squeeze treatment procedure has several advantages over conventional squeeze methods, especially for water sensitive formations and wells with poor reservoir support. An emulsified squeeze should allow oil production to return to pretreatment levels in a short period of time. It could also eliminate the potential for water induced formation damage, as well as the need for nitrogen lift to bring the well back to production. Consequently, there could be significant difficulties in the injection of the emulsified slugs into the formation. The viscosity is estimated to be in the range of 12 cP - 20 cP (possibly higher), depending on the required loading of the emulsifying chemical. In addition, the cost of an emulsified squeeze will be significantly higher due to additional expensive chemicals, and the need for a service company to perform the job.

Saudi Aramco has been supporting research consortia, joint industrial projects (JIPs) with academic (Rice University and Heriot-Watt University) and research institutes (Scaled Solution Limited). Their new findings are continuously incorporated in field trials and optimization of SIS programs.

Many SIS programs using acidic phosphonate scale inhibitors, though successful in controlling scaling problems, result in higher initial water production after treatment for a significant number of wells. There was no systematic field study to correlate this outcome with the acidity of the scale inhibitor; however, JIP research from Rice University and Heriot-Watt University concluded that the primary controlling factor for inhibitor retention and return is the acidity and concentration of the inhibitor[18]. Therefore, a partially neutralized scale inhibitor treatment for carbonate formations is more effective than an acidic chemical.

Heriot-Watt University modeled the impact of diesel and aqueous overflush on SIS treatment life using a two-phase near wellbore simulator. A special study was conducted for splitting the overflush using part water and part diesel, as well as the order in which these are injected in the split overflush. The simulations indicated a best treatment life for 100% water and worst for 100% diesel, and a significantly improved life for split overflush compared to that of 100% diesel. In addition, water followed by diesel is the preferred sequence in the overflush[19, 20]. This could be due to the fact that the initial water injection during the overflush causes desorption of the chemical near the wellbore and displaces it further away from the wellbore, as does the following diesel overflush stage displaces the aqueous chemical slug further into the reservoir. An example of this simulation conducted for Well-F is shown in Fig. 5. The squeeze life for an MIC of 2 ppm increased by an additional year for the split overflush compared to diesel alone. By successfully adopting this split of 25% water and 75% diesel, we were able to balance the

> In spite of the success of the scale inhibition treatments for vertical and simple horizontal wells, placement of chemicals in long horizontal and complex producers, such as MRC and ERC wells is a challenge.

drawback and benefits of both water and diesel, and this has resulted in improved SIS treatments[14].

**SIS Treatments**

Guidelines used for old and new SIS programs for vertical, deviated, and horizontal wells were the same as mentioned earlier[14]. An Excel based program based on these new guidelines was developed. Details of some newly treated wells are given in Table 2.

In spite of the success of the scale inhibition treatments for vertical and simple horizontal wells, placement of chemicals in long horizontal and complex producers, such as MRC and ERC wells is a challenge, Fig 2. Abqaiq field has some multilateral horizontal (without control of the laterals) and SML (with control valves). Some trial SIS treatments were conducted based on the flow characteristics of the laterals, Table 3. Lessons learned from these pre- and post-production data will be used to revise the treatment for other complex wells.

The PlaceiT simulator from Scaled Solution Limited can be used for placement of SIS chemicals/fluids in complex wells[21]. Initial placement modeling simulations for Well-E0E, a four lateral multilateral producer, shows that a standard bullhead squeeze will have difficulty treating the lower laterals (L2, L1 + MB) as significant crossflow into L4 is expected. Therefore, conventional bullhead treatment can treat only L4 as almost all the injection fluids will go into this first lateral near the heel section. Increasing the injection rate and/ or viscosifiying the treatment may help counteract the crossflow, but placement would remain a challenge. Targeting treatments to each individual lateral ensures the delivery of inhibitor to all parts of the wellbore, and it is feasible for this SML well; however, treating all laterals requires enormous quantities of the treatment fluids. In addition, using significant quantities of overflush diesel would create logistical problems for operations, not only for bringing in truck loads of diesel, but also later in GOSP operations. Therefore, based on the flow characteristics of the laterals, it was planned to treat L4 and L2 only. Similar planning was done for the other SML wells. Less expensive bullhead injection was preferred to CT for the two multilateral horizontal wells that do not have any controls. Total fluid production decreased drastically in the initial phase after treatment for one of these multilateral horizontal producers; however, the production level improved after flushing the well at high choke for 48 hours. Subsequently, the well was tested through both the test trap and a multiphase flow meter to confirm its production rate. The rate test shows 5.8 thousand

"Targeting treatments to each individual lateral ensures the delivery of inhibitor to all parts of the wellbore, and it is feasible for this SML well; however, treating all laterals requires enormous quantities of the treatment fluids."

barrels of oil per day (MBOD) with 15% water cut as compared to the pretreatment test of 5.8 MBOD with 20% water cut. Table 4 summarizes the effect of SIS treatment on the productivity of the crude oil and water rates. Although, the majority of these wells have maintained or improved the crude productivity with either the same or slightly decreased water cut after the SIS, the net effect on crude and water production remained the same. There were no adverse effects due to the modified SIS program. This clearly shows the advantage of the modified SIS with: 1) Partially neutralized scale inhibitor, and 2) 25% water and 75% diesel in the split overflush.

Lessons learned from this pre- and post-SIS productivity and diagnosis results using the PlaceiT simulator will be used to develop further improved SIS programs for the other complex wells in Abqaiq field, as well as other carbonate formation fields.

In summary, this article detailed a systematic scaling potential evaluation of all wet producers for their priority of various cost-effective scale inhibitor treatments. This article also gives some of the drawbacks of conventional SIS treatments and how these were minimized with modified SIS programs using JIP results and case histories of some treated complex multilateral wells.

## Summary and Conclusions

1. Almost all producers have $CaCO_3$ scaling potential that can cause scaling problems when the GOSP operating pressure drops to 250 psig.
2. A majority of producers have low sulfate scaling potentials that may not be a problem.
3. All producers are prioritized for scale inhibitor treatment based on their scaling potential.
4. An encapsulated scale inhibitor treatment program was performed for one well and a modified SIS for the remaining wells.
5. Modified SIS treatments were a success for GOSP-C producers in the Abqaiq field.

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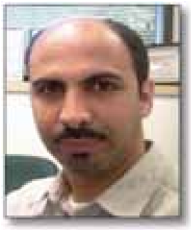

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Texas A&M University at Qatar

**Mazen Y. Kanj**
Saudi Aramco

**Medhat Kamal**
Chevron Energy Technology Company

**Mehdi Samama**
Repsol Explorations Murzuq (REMSA)

**Menour Jazzal Al-Shammari**
Kuwait Oil Company

**Mohamed Wael Helmy**
ExxonMobil Upstream Ventures

**Mohammed Badri**
Schlumberger

**Mohammed Doghmi**
Schlumberger

**Moustafa Oraby**
Halliburton

**Nasser Al Mossalli**
Bahrain Petroleum Company

**Nawzad Khurshid**
Occidental Oil & Gas

**Riyaz Kharrat**
National Iranian Oil Company

**Shalawn K. Jackson**
ExxonMobil Upstream Research Company

**Sultan Masoud Al-Merikhi**
GDF Suez Qatar Block 4 Company

**Thomas Blasingame**
Texas A&M University

**Vipin Gupta**
Petroleum Development Oman

**Wajid Rasheed**
EP Rasheed

**Xu Dong Jing**
Shell

**Younane Abousleiman**
University of Oklahoma

## Conference Organisers

SPE International
Society of Petroleum Engineers

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Arabian Exhibition Management

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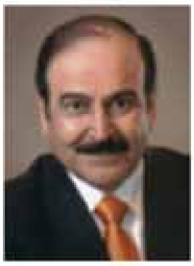
# Opening Addresses

## Sunday, 25 September 2011

### 1630–1730 hours
### OPENING CEREMONY

*Room 1 & 2*

**Official Opening by**

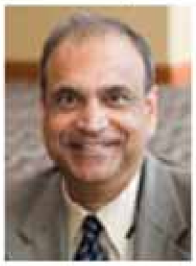


**H.E. Dr. Abdul Hussain bin Ali Mirza**
*Minister of Energy*
*Kingdom of Bahrain*

**Address by**

**H.E. Mohamed bin Dha'en Al-Hamili**
*Minister of Energy*
*UAE*

**Address by**



**Ganesh Thakur**
*2012 SPE President*
*Vice President, Global Advisor & Chevron Fellow*
*Chevron Energy Technology Company*

### 1730–1930 hours
### EXECUTIVE PLENARY SESSION

*Room 1 & 2*

**Shaping the Future: Innovating Beyond Limits**

Hydrocarbon is the world's most efficient source of energy; however, the operational challenges in oil and gas discovery and recovery are increasing. Operations have extended to remote areas tapping new reservoirs and striving to increase recovery factors beyond accepted limits while working to preserve the environment for future generations. The industry is facing the challenge with adaptively intelligent technologies, out-of-the-box business models and exceptional human skills. Innovation in E&P is a definite must and one company's success is rather defined in its preparedness to question the status quo to break set records for improvement. The executive plenary session explores innovation in E&P. It examines the standards for fostering new and innovative ideas across the industry and challenges these standards for innovating beyond limits.

**Session Moderator:**

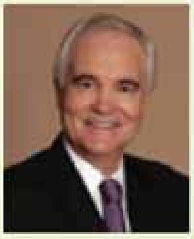
**Mohammad A. Husain**
*Deputy Chairman and Deputy Managing Director Planning and Gas*
**Kuwait Oil Company**

**Speakers:**

**Amin H. Nasser**
*Senior Vice President Upstream*
**Saudi Aramco**

**Abdul Munim S. Al-Kindy**
*CEO*
**ADCO**

**Andrew Gould**
*Chairman and CEO*
**Schlumberger**



**Chad Deaton**
*Chairman, President and CEO*
**Baker Hughes**

**Lee Tillman**
*Vice President Engineering*
**ExxonMobil Development Company**

**Sami F. Al-Rushaid**
*Chairman and Managing Director*
**Kuwait Oil Company**

**Sponsored by Kuwait Petroleum Corporation & Subsidiaries**

### 1930 hours
### CONFERENCE DINNER RECEPTION

*Al Ghazal Ballroom, Ritz Carlton Hotel*

## Tuesday, 27 September 2011

Sponsored by Shell

### 0800–1000 hours
### INDUSTRY BREAKFAST SESSION

*Hall 2, lunch area*

#### Financing the Change

Some analysts foresee that the oil industry will spend around 15 trillion dollars during the coming 10 years to meet the expected future oil and gas demand. They further estimate that oil and gas reserves additions from recovery enhancement will most likely supersede the additions from grass root exploration.

- **What are the major changes that we expect to see during the coming decade?**
- **Who will develop strategies and executing these changes?**
- **How these changes may be handled and financed?**

**WHAT?**

- Increasing focus on enhancing recovery from producing assets.
- Increasing focus on hydrocarbon production from tight, deep and unconventional reservoirs.
- Increasing environmental awareness and thus environmental control and constraints.
- Cost and risk attached to the incremental development barrels will be progressively higher than current.
- Technological advancement and innovative thinking will be the drive force for achieving all above.
- Managing uncertainties specially those linked to future demand and pricing.

**WHO?**

- **Host Governments** to either directly finance or make the necessary changes to enable and encourage investor participation.
- **International and independent companies** will be the main drivers of implementing these inevitable changes.
- **Service companies** will be required to align their research and development functions to the requirements of the end users. They may also find merits in forming alliances with oil companies to shoulder some risk for bigger rewards.
- **Investment Institutions and banks** will need to digest and address the future financing requirements of the oil industry. Politics is taking a dominant role in this area that may require designing innovative business and financing solutions to manage those changes.

**HOW?**

The relationship between any **two or more parties** of the above stakeholders will mandate introducing innovative business models for ensuring growth and sustained success. A dedicated effort must be made to first understand the strengths and weaknesses of the currently used models such as EPSA's, DPSA's, Services and buy-back agreements, etc., in the current business environment and to design and develop additional business solutions to encourage collaboration between the various parties and to build the momentum for financing and managing the expected inevitable major changes.

**Session Moderator:**

**Anwar Khalaf**
*General Manager, Exploration & Petroleum Engineering*
**Bahrain Petroleum Company**

**Speakers (to be confirmed)**

## Monday, 26 September 2011

## 1030–1230 hours

## PANEL SESSION 1

*Room 1*

### Shape of the Future Relation between the Industry Players - IOCs, NOCs and the Service Industry?

The alliance vision for new oil and gas projects has changed significantly over the past several years because of the need to bring massive production projects on line in shorter times. No company can do it on its own. The involvement and cooperation of international oil companies (IOCs), national oil companies (NOCs), and service companies has become essential. The motive for this new alliance vision is the scale of challenges facing new projects, including new innovative technology applications and the ability to secure and manage production. In today's hard-to-access oil, technology plays an increasingly critical role in the success of projects. NOCs, IOCs and service companies relations and partnerships presents a set of opportunities as well as challenges for technological development.

To understand the various skills required, it is worth examining more closely the respective roles of IOCs, NOCs, and service companies in the current innovation environmental science.

Because each oilfield is different, there are demands for different technological necessities. NOCs are best suited to provide such knowledge back to service companies and IOCs to facilitate the next wave of technological innovation.

**IOCs** have been the leaders in the "ability to produce oil." The knowledge and expertise cultivated from more than 100 years in managing resources around the world resides within these companies, and they have created many of the game-changing technological breakthroughs that facilitate today's oil and gas production. IOCs also have a very strong global intellectual-property (IP) portfolio that covers the entire value chain from exploration to distribution. Their manufacturing ability is a unique strength for future innovations.

**NOCs** own huge amounts of reserves and most of the future supply of oil and gas will come from NOCs. They are dedicated to developing their staff with the technological capability and skills to work side by side with service companies and IOCs. Many NOCs have begun in-house technology-development programmes tailored to their own needs.

**Service Companies:** in today's world, it is impossible to produce without the involvement of service companies. Service companies started off in operations but now successfully manage technologies and have been responsible for numerous technological innovations. In the process, they have managed to develop a strong IP portfolio with respect to their core competencies. Recently, service companies have begun to partner with NOCs directly without the involvement of IOCs.

**Session Moderators:**

**Khaled Nouh**
*President Middle East*
**Baker Hughes**

**Robert H. (Bob) Gales**
*Vice President – Geoscience*
**Weatherford**

**Panellists:**

**Gerald Schotman**
*Executive VP - Innovation, R&D*
*Shell Chief Technology Officer*
**Royal Dutch Shell**

**Hosnia Hashim**
*Deputy Managing Director (North Kuwait)*
**Kuwait Oil Company**

**Nicholas Gee**
*Group Vice President Completion and Production*
**Weatherford**

# Panel Sessions *continued*

## Monday, 26 September 2011

## 1030–1230 hours

## PANEL SESSION 2

*Room 2*

### Avoiding Past Mistakes

One of the most important ways to improve results is to learn from our past mistakes. Often in geoscience and engineering, we find ourselves presenting successes and down playing failures. That is a natural human tendency. Yet experience has shown that it is our mistakes that often teach us the most. Benefitting from the past means embracing our mistakes, understanding them, learning new behaviours/attitudes and setting forth strategies to avoid them in the future. The final step is to communicate these learnings clearly and broadly throughout our organisations.

Albert Einstein has said, **"Anyone who has never made a mistake has never tried anything new".**

What is more important is to learn from the mistakes and how to overcome them by mastering the art and science of 'I know what I don't know'. The larger the ambitions, the more dependent one will be on the ability to overcome and learn from mistakes.

**How to review complex mistakes?**
The more complex the mistake, the further back you will need to go and the more careful and open-minded you need to be in your own investigation. If multiple people were involved (e.g. your superiors, co-workers and contractors), you want to hear each persons' account of what happened. Each person will emphasise different aspects of the situation based on their skills and circumstances, getting you closer to a complete view of what took place.

**Lesson learnt:** Until you work backwards, hours or days before the actual mistake or event, you probably won't see all of the contributing factors and can't learn all of the possible lessons. You may even need to bring in an objective outsider to help sort things out. Progress won't be a straight line but if you keep learning you will have more successes than failures, and the mistakes you make along the way will help you get to where you want to go.

**Some good practice investigating mistakes are:**

- What was the probable sequence of events?
- What information could have avoided the mistake?
- What would we do differently if in this exact situation again?
- What small mistakes, in sequence, contributed to the bigger mistake?

**Session Moderators:**

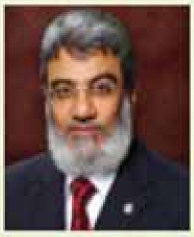
**Mohammad A. Husain**
*Deputy Chairman & Deputy Managing Director Planning and Gas*
**Kuwait Oil Company**

**Robert Bunch**
*Technical Manager*
**Exxon (Al Khalij) Incorporated**

**Panellists:**

**Adnan Ghabris**
*CEO and Managing Director*
**NPS Energy**

**Balgacem Chariag**
*President EH Operations*
**Baker Hughes**



**Khalid A. Al-Sumaiti**
*Deputy Managing Director, E&P Directorate*
**Kuwait Oil Company**

**Saif Al-Hinai**
*Oil and Gas Asset Director*
**Petroleum Development Oman**

## Panel Sessions *continued*

### Tuesday, 27 September 2011

### 1030–1230 hours

### PANEL SESSION 3

***Room 1***

#### Value Chain Integration in Mega Projects: Who and What Drives the Project to Success

The Value Chain concept, first published by Michael Porter in 1985, defines the activities of designing, developing, manufacturing, distributing and servicing a product as a Value Chain, where each step in the process adds value to the product. This concept is easy to understand and apply, even from a timeline point of view, when only considering a single company or business unit, but it becomes significantly more complex as we look at Mega Projects, such as the field development projects currently being implemented or reviewed particularly in the Middle East.

The "end product" of these Mega Projects is long-term, high level sustained production capacity and high recovery factor at the lowest possible cost. In order to achieve this goal, the value chains of the various disciplines involved have to be interwoven in terms of process and timeline to reduce commercial and technical risk, creating a "Value Mesh". As an example, the optimum time to design the handling capacity of surface production facilities is in the very early stages of field development – later adjustments in terms of capacity are disproportionately CAPEX intensive. Unfortunately, at this early stage, the oil or gas field will only have been characterised based on a very limited amount of subsurface data and the risk of future "surprises" will invariably be very high. Such "surprises" may include a structurally more complex, barriers to flow, lateral variations in oil quality or reservoir permeability, insufficient pressure support calling for artificial lift, etc.

This panel will highlight these and other challenges and discuss how a thorough understanding of the various value chains involved in a Mega Project and the way they interact can lead to the creation of a Value Mesh, driven by knowledge, integration and communication, such that accurate real-time information drives better technical and financial decision.

**Session Moderators:**

**Abdulaziz A. AbdulKarim**
*General Manager, EXPEC Computer Center*
**Saudi Aramco**

**Khaled Nouh**
*President Middle East*
**Baker Hughes**

**Panellists:**

**Jamal Ibrahim**
*Senior Vice President Middle East – India*
**Worley Parsons**

**Alberto Matucci**
*General Manager Operations, Turbomachinery*
**GE Oil & Gas**

**Khaled Abu-Nasrah**
*President – Middle East Region*
**KBR International**

**Rob Brouwer**
*Vice President Project Engineering Chief Engineer*
**Shell**

**Nasser Wohaibi**
*Facility Planning Manager*
**Saudi Aramco**

## Panel Sessions *continued*

### Tuesday, 27 September 2011

**1030–1230 hours**

### PANEL SESSION 4

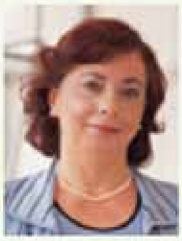
*Room 2*

#### Capacity and Skills Development within Industry: Innovation vs. Implementation

Our industry is facing exciting changes that present both opportunities and challenges for the industry's most important asset – its people. With new innovations enabling us to do more with less, these changes present great opportunities for new ways of thinking and new ways of working. This creates exciting possibilities for people eager to push the limits and who are seeking an industry with long term growth potential. However, with this come challenges – 'the big crew change', attracting new blood into the industry, development of new skill sets, and the like. This session is focused on how we give and get the most to and from our most precious resource – our people.

**Session Moderators:**

**Aaron Gatt Floridia**
*President Middle East and Asia*
Schlumberger



**Zara Z. Khatib**
*Chief Technologist, Gas Research Centre*
Petroleum Institute/Shell

**Panellists:**

**Bernie Vining**
*Chief Geoscientist*
Baker Hughes

**Clement Edwards**
*Petroleum Engineering Coordinator*
Shell

**Fareed Abdullah**
*Senior Vice President BAB and Gas*
ADCOO

**Hashim S. Hashim**
*Deputy Managing Director (South & East Kuwait)*
Kuwait Oil Company

**Huda Al-Ghoson**
*General Manager Training & Development*
Saudi Aramco

## Panel Sessions *continued*

## Wednesday, 28 September 2011

### 0800–1000 hours

### PANEL SESSION 5

*Room 1*

### Technology Development: How Fast?

It is deemed that the demand for oil and gas will continue to rise due to the increase in world population and the spread of economic and technological prosperity in regions considered less developed. The biggest challenge facing the oil and gas industry is to meet the future world demand for energy at an affordable price. What are the pathways and potential business models to continue the role of R&D as a driving force for future E&P? Should we or should we not invest in blue sky technologies? Are we spending enough? Who should lead? Responding to a powerful combination of the changing business climate and major scientific and technological advances, new models and trends for industrial R&D have emerged. What are the consequences of these trends in view of future business and technological challenges facing the oil and gas industry? How will trends in these key technologies impact applications for E&P? Future E&P performance may be even more dependent on continued technological advances than the R&D system or model. What are the most influential technologies of the future for E&P? The research environment in universities and government research organisations are also facing major changes and challenges. Will new expectations from industrial organisations significantly change their key contribution to long-term basic research and graduate education?

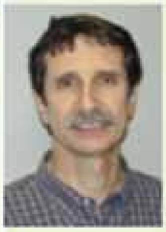
The session addresses the relevance of having a well established R&D model for oil and gas operators and service companies, universities and research labs, and government in delivering influential technologies fast; VERY FAST in E&P!

**Session Moderators:**

**Abdulaziz O. Al-Kaabi**
*Chief Technologist*
**Saudi Aramco**

**Sidqi Abu Khamsin**
*Chairman, Petroleum Engineering Department*
**King Fahd University of Petroleum and Minerals**

**Panellists:**



**Dan Georgi**
*Vice President Regional Technology Centers*
**Baker Hughes**

**Jeroen Regtien**
*Vice President Hydrocarbon Recovery Techologies*
**Shell**

**Michael Bittar**
*Vice President Technology*
**Halliburton**

**Ram Shenoy**
*Vice President Research*
**Schlumberger**

**Samer AlAshgar**
*Manager EXPEC Advanced Research Center*
**Saudi Aramco**

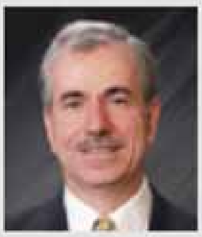
**Shahab D. Mohaghegh**
*Professor Petroleum & Natural Gas Engineering*
**West Virginia University**

# Keynote Speakers in Technical Sessions

**Keynote speakers in technical sessions is a new feature at MEOS 2011.**

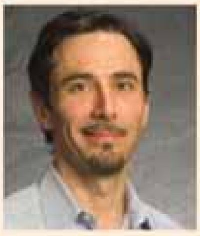
## Monday, 26 September 2011

**SESSION 1** — *Room 1*
*0800 hours*
**STIMULATION AND PRODUCTIVITY ENHANCEMENT - 1**



**Joseph A. Ayoub**
*Reservoir and Production & Completion Domain Career Leader*
**Schlumberger**

**SESSION 12** — *Room 6*
*1400 hours*
**RESERVOIR MODELLING - 1**



**Hamdi Tchelepi**
*Associate Professor, Energy Resources Engineering and Co-Director Center for Computational Earth and Environmental Sciences (CEES)*
**Stanford University**

**SESSION 14** — *Room 2*
*1630 hours*
**RESERVES AND ECONOMICS**

**Ganesh Thakur**
*2012 SPE President*
*Vice President, Global Advisor & Chevron Fellow*
**Chevron Energy Technology Company**

**SESSION 15** — *Room 2*
*1630 hours*
**EOR LAB INVESTIGATIONS**

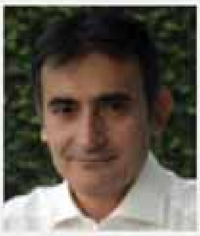
**S.M. Farouq Ali**
*Consultant*
**PERL Canada Limited**

## Tuesday, 27 September 2011

**SESSION 24** — *Room 6*
*1330 hours*
**RESERVOIR MONITORING AND TESTING - 1**

**Medhat M. Kamal**
*Senior Research Consultant*
**Chevron Energy Technology Company**

**SESSION 27** — *Room 3*
*1600 hours*
**FACILITIES**

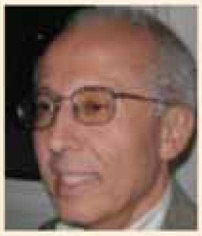


**Cosan Ayan**
*Reservoir Engineering Advisor*
**Schlumberger**

**SESSION 29** — *Room 5*
*1600 hours*
**PEOPLE DEVELOPMENT**

**Craig W. Van Kirk**
*Professor*
**Colorado School of Mines**

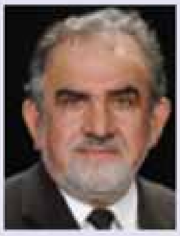
**SESSION 30** — *Room 6*
*1600 hours*
**RESERVOIR MONITORING AND TESTING - 2**



**Fikri J. Kuchuk**
*Chief Reservoir Engineer*
**Schlumberger**

## Wednesday, 28 September 2011

**SESSION 32** — *Room 3*
*0800 hours*
**I-FIELD**



**Iraj Ershaghi**
*O.B Milligan Professor and Director Petroleum Engineering Program*
**University of Southern California**

**SESSION 33** — *Room 1*
*1030 hours*
**UNCONVENTIONAL TECHNOLOGIES IN E&P: A CANDID REACH TO OTHER FIELDS**

**Metin Sitti**
*Associate Professor, Mechanical Engineering*
**Carnegie Mellon University**

**Mazen Y. Kanj**
*PE Specialist*
**Saudi Aramco**

**Roland N. Horne**
*Professor-Energy Resources*
**Stanford University**

**Ulrich B. Wiesner**
*Spencer T. Olin Professor*
**Cornell University**

**SESSION 37** — *Room 5*
*1030 hours*
**ADVANCED COMPLETION SYSTEMS**

**Mark Johnson**
*Senior Artificial Lift Consultant, EMPC Subsurface Engineering & Operations Support*
**ExxonMobil**

## Session Schedule

*All alternate papers will be presented as posters at specific time slots during coffee breaks. Please refer to the Poster Presentation schedule.*

# Session One

**Room 1** — **0800–1000 hours**

**STIMULATION AND PRODUCTIVITY ENHANCEMENT - 1**

Session Chairpersons: **Frank Chang**, *Schlumberger*

| Time | Paper # | Paper Title & Author |
|---|---|---|
| 0800 hours | | **Keynote Speaker:** **Joseph A. Ayoub** *Reservoir and Production & Completion , Domain Career Leader, Schlumberger* **Stimulation Technology: Broad, Deep and Successful** |
| 0830 hours | 141239 | **Distributed Temperature Sensing (DTS) Enables Injectivity Visualisation to Enhance Stimulation Efficiency** *M.A. Fahim, A.A. Keshka, A. Al Marzooqi, D. Abdallah, ADCO; G. Brown, F. Ali Neyaei, L. Hudson, Schlumberger* |
| 0900 hours | 141812 | **Completion and Stimulation Challenges and Solutions for Extended-Reach Multizone Horizontal Wells in Carbonate Formations** *A. Jackson, J. Jorden, M. A. Al Marzouqi, A. E. Al Mahri, ZADCO; S. Keller, C. Shuchart, ExxonMobil* |
| 0930 hours | 142675 | **Development and Testing of a Novel Corrosion Inhibitor Technology for Acid Corrosion** *K. Seth, B.A. Evans, Baker Hughes; A. Gabrysch, Shell* |
| | Alternate 141021 | **Evolution of Coiled Tubing Matrix Stimulation for Gas Wells in Saudi Arabia** *M. Al-Atwi, J. R. Solares, R. Amorocho, F. Garzon, Saudi Aramco; W. Kharrat, J. Stuker, I. Naji, Schlumberger* |
| | Alternate 141639 | **Perforating Long Horizontal Section with Tractor Brings Significant Gains in Completion Efficiency** *M. Badri, A. Al-Hashami, M. Al-Masroori, Petroleum Development Oman; A. Salsman, M. S. Jumaat, H. Situmorang, Schlumberger* |

# Session Two

**Room 2** — **0800–1000 hours**

**UNCONVENTIONAL GAS**

Session Chairpersons: **Adnan Kanaan,** *Saudi Aramco and* **Nasser K. Al-Mossalli**, *Bahrain Petroleum Company*

| Time | Paper # | Paper Title & Author |
|---|---|---|
| 0800 hours | 141085 | **Accounting for Adsorbed Gas in Shale Gas Reservoirs** *S.A. Mengal, R.A. Wattenbarger, Texas A&M University* |
| 0830 hours | 141813 | **Evolution of Tight Gas Fracturing Methodology in the Lower Paleozoic Sandstone Formations in Saudi Arabia** *Z. Al-Jalal, L. Ramsey, N. Gurmen, D. Kalinin, Schlumberger* |
| 0900 hours | 141840 | **Challenges of Wireline Formation Testing and Fluid Sampling in Tight, Low Permeability Gas Reservoirs: Case Study from Saudi Arabia** *F. A. Omokaro, N. M. Musharfi, Saudi Aramco; W. Soliman, M. Rourke, M. Eid, Halliburton* |
| 0930 hours | 141104 | **The Potential Pitfalls of Using North American Tight and Shale Gas Development Techniques in the North African and Middle Eastern Environment** *A.N. Martin, R. Eid, Baker Hughes* |
| | Alternate 139782 | **Analysis of "Lower limit Formation" in Low Permeability Sands of Ordos Basin** *L. Xiao, Z. Mao, China University of Petroleum; Y. Shi, H. Guo, PetroChina* |
| | Alternate 140971 | **NMR Stabilisation and Relaxation in a Single Pass Provides Reservoir Solutions** *C.H. Smith, S. Ramakrishna, E. Menendez, Halliburton* |



***Subject to change.*** *Changes after 6 June 2011 will be reflected in the Conference Programme.*

## Session Schedule *continued*

*All alternate papers will be presented as posters at specific time slots during coffee breaks. Please refer to the Poster Presentation schedule.*

# Session Three

**Room 3** — **0800–1000 hours**

**LOW COST DRILLING**

Session Chairpersons: **Hamad Saleh Al Junaibi,** *ZADCO and* **Sami E. El Halfawi,** *Weatherford*

| Time | Paper # | Paper Title & Author |
|---|---|---|
| 0800 hours | 141598 | **Case-Based Reasoning: Predicting Real-Time Drilling Problems and Improving Drilling Performance**<br>*H. Raja, Halliburton; F. Sørmo, M. L. Vinther, Verdande Technology* |
| 0830 hours | 140459 | **New Technique to Side Track Across Hard Formation in the North of Oman**<br>*A.A. Al Salmi, Y. Al Haji, S. Al Hamhami, I. Sabhi, Petroleum Development Oman; A. Al Fadhli, Halliburton* |
| 0900 hours | 140023 | **Integrated Pre-Well Planning Process to Improve Service Quality and Decrease Risk through Cooperation between Drilling and Geoscience**<br>*J.M. Aldawood, K. Ahmed, Y.S. Al Ansari, B.A. Zubairi, Baker Hughes; M.X. Hanafi, Saudi Aramco* |
| 0930 hours | 141673 | **Adjustable Gauge Stabiliser and Torque and Reduction Tools Reduce Overall Drilling Times by at Least 20%: A Case Study**<br>*J.E. McCormick, G. Osorio, Weatherford; M.E. Barth, University of Texas at Austin; J.H. Andachi, EP Petroecuador* |
| | Alternate 141486 | **New PDC Technology Improves Drilling Performance and Sets New Penetration Record in Rageshwari Field, Rajasthan, India**<br>*A. Upadhaya, Cairn Energy India; A.R. Chowdhury, R. Borgaonkar, Baker Hughes* |

# Session Four

**Room 4** — **0800–1000 hours**

**ENHANCED WATERFLOOD**

Session Chairpersons: **Ali Meshari**, *Saudi Aramco and* **Hasan S. Al-Hashim,** *King Fahd University of Petroleum and Minerals*

| Time | Paper # | Paper Title & Author |
|---|---|---|
| 0800 hours | 142668 | **Enhanced Waterflood for Middle East Carbonate Cores - Impact of Injection Water Composition**<br>*R. Gupta, G.G Smith, L. Hu, T. Willingham, M. Lo Cascio, J.J. Shyeh, C.R. Harris, ExxonMobil* |
| 0830 hours | 141114 | **Laboratory Investigation of Low Salinity Waterflooding on Reservoir Rock Samples from the Frøy Field**<br>*N. Hadia, H. H. Lehne, K. G. Kumar, K. Selboe, J. Å. Stensen, and O. Torsæter, Norwegian University of Science & Technology* |
| 0900 hours | 141082 | **Smart Water-Flooding for Carbonate Reservoirs: Salinity and Role of Ions**<br>*A.A. Yousef, S. Al Saleh, M.S. Al Jawfi, Saudi Aramco* |
| 0930 hours | 141497 | **Pushing the Envelope for Polymer Flooding Towards High-Temperature and High-Salinity Reservoirs with Polyacrylamide Based Ter-Polymers**<br>*E.C. Vermolen, M.J. Van Haasterecht, S.K. Masalmeh, M.J. Faber, D.M. Boersma, Shell; M.A. Gruenenfelder, SNF Oilfield Group* |

## Session Schedule *continued*

*All alternate papers will be presented as posters at specific time slots during coffee breaks. Please refer to the Poster Presentation schedule.*

# Session Five

**Room 5** — **0800–1000 hours**

### SAND MANAGEMENT

Session Chairpersons: **Nawzad R. Khurshid**, *Occidental Oil & Gas and* **Wajid Rasheed,** *EP Rasheed*

| Time | Paper # | Paper Title & Author |
|---|---|---|
| 0800 hours | 141654 | **Case History of the First Global Installation of a Gravel Pack System that Allows Continuous Pay Zone Chemical Treatment Pumping without Interrupting Production**<br>*N.D. Surveyor, A.D. Amaral, M. Pinto; Baker Hughes* |
| 0830 hours | 141878 | **Achieving Target Solids-Free Gas Rate from Highly Unconsolidated Sandstone Formation Intervals**<br>*N. Abulhamayel, J. R. Solares, W. Nunez, A. Malik, M. Basri, A. McWiliams, Saudi Aramco; O. Tahir, M. Abduldayem, Weatherford* |
| 0900 hours | 141776 | **Efficient Cleanouts Improve Deviated Well Economics: Case Histories Offshore Saudi Arabia**<br>*T. Green, T. Ramsey, E.A. Bedaiwi, J. Li, Baker Hughes* |
| 0930 hours | 142633 | **Zeta Potential Investigation and Mathematical Modelling of Nanoparticles Deposited on the Rock Surface to Reduce Fine Migration**<br>*M. Ahmadi, A. Habibi, P. Pourafshari, University of Tehran; S. Ayatollahi, Shiraz University* |
| | Alternate 141054 | **Field Application of Chemically Treated Substrate in Pre-Packed Well Screen**<br>*J.B. Weirich, T.D. Monroe, B.B. Beall, A.K. Singh, D. Gupta, Baker Hughes; J. McBee, Nippon Oil Exploration* |
| | Alternate 142700 | **Inflow Control Devices Minimises Annular Velocity in Gas Wells with Standalone Screen Completions**<br>*R.E. Regulacion, N. Shahreyar Halliburton* |
| | Alternate 140207 | **An Economic Evaluation Model (EEM) for Selecting Sand Management Technology**<br>*B. Dong, L. Ren, China National Petroleum Corporation; X. Wu, China University of Petroleum Beijing* |

# Session Six

**Room 6** — **0800–1000 hours**

### EOR SIMULATION AND MODELLING

Session Chairpersons: **Sunil Kokal**, *Saudi Aramco and* **Xu Dong Jing**, *Shell*

| Time | Paper # | Paper Title & Author |
|---|---|---|
| 0800 hours | 142542 | **Mobility Control for Gas Injection in Heterogeneous Carbonate Reservoirs: Comparison of Foams versus Polymers**<br>*S.K. Masalmeh, L. Wei, C.P. Blom, Shell* |
| 0830 hours | 142623 | **Integrated History Matching Simulation Study of the First Miscible $CO_2$-EOR Pilot in Abu Dhabi Heterogeneous Carbonate Oil Reservoir**<br>*S.K. Al Hajeri, A.H. Al Basry, S. Negahban, ADCO; S.G. Ghedan, The Petroleum Institute* |
| 0900 hours | 141469 | **Miscible $CO_2$ Injection in Highly Heterogeneous Carbonate Cores: Experimental and Numerical Simulation Studies**<br>*A.A. Aleidan, D.D. Mamora, Texas A&M University* |
| 0930 hours | 141283 | **Full Barrel Analysis: A Simulation Model Interrogation Tool to Assess Sweep Efficiencies and Identify Targets for Improved Oil Recovery**<br>*M. S. Beckman, J. L. Dickson, C. R. Harris, D. S. Frankel, ExxonMobil* |
| | Alternate 142618 | **Modelling the Oil Bank Formation During Steam Flood**<br>*A.F. Alajmi, Kuwait University* |
| | Alternate 140960 | **The Modification of the Dykstra-Parsons Method for Inclined Stratified Reservoirs**<br>*N.A. El Khatib, Universiti Teknologi PETRONAS* |



***Subject to change.*** *Changes after 6 June 2011 will be reflected in the Conference Programme.*

## Session Schedule *continued*

*All alternate papers will be presented as posters at specific time slots during coffee breaks. Please refer to the Poster Presentation schedule.*

# Session Seven

| *Room 1* | | **1400–1600 hours** STIMULATION AND PRODUCTIVITY ENHANCEMENT - 2 |
|---|---|---|
| | | Session Chairpersons: **Ashraf Tahini**, *Saudi Aramco and* **Joseph A. Ayoub**, *Schlumberger* |
| ***Time*** | ***Paper #*** | ***Paper Title & Author*** |
| *1400 hours* | **142512** | **Successful Application of Novel Fiber Laden Self-Diverting Acid System During Fracturing Naturally Fractured Carbonates in Saudi Arabia** *J.A. Leal Jauregui, A.R. Malik, W. Nunez Garcia, Saudi Aramco; T. Bukovac, B. Sinosic, M.N. Gürmen, Schlumberger* |
| *1430 hours* | **142571** | **Innovative Method to Control Acid Placement During the Stimulation of Wells with High Water Cut** *M. Harbi, R. Said, I. Arnaout, S. Haldar, F. Al-Subaie, C. Jenkins, Saudi Aramco; A. Burov, W. Kharrat, D. Ahmed, Schlumberger* |
| *1500 hours* | **141238** | **A Unique Stimulation Approach to Enhance Production Efficiency of Horizontal Wells in Heterogeneous Carbonate Reservoirs** *M.A. Fahim, A.A. Keshka, A. Al Marzooqi, E. Assreti, H. Helmy, D. Salim, ADCO; F. A. Neyaei, M. Rafieenia, L. Hudson, Schlumberger* |
| *1530 hours* | **141593** | **Novel Foamer Application for Enhanced Oil Production** *S.B. Debord, S. Lehrer, N.C. Means, S. R. Crosby, Baker Hughes* |

# Session Eight

| *Room 2* | | **1400–1600 hours** DEEP WATER DRILLING |
|---|---|---|
| | | Session Chairpersons: **Omar Faraj**, *Saudi Aramco and* **Scott Bittner**, *Schlumberger* |
| ***Time*** | ***Paper #*** | ***Paper Title & Author*** |
| *1400 hours* | **142540** | **Role of Formation Pressure and Sonic Measurements While Drilling in Pre-Drill Well Design Validation and Syn-Drill Well Design Optimisation: Case Studies from Deepwater India** *V. Agrawal, R. K. Singh, J. Singh, Schlumberger; M.I. Shaikh, F. Dotiwala, Oil and Natural Gas Corporation* |
| *1430 hours* | **140981** | **Reducing Safety Incidents While Lifting and Handling Drilling Jars: A Case Study** *C. D. Evans, R. Reitsma, E. Ramsay, Weatherford* |
| *1500 hours* | **140151** | **A Real Mathematical Model to Compute the PDC Cutter Wear Value to Terminate PDC Bit Run** *G.M. Gouda, M. Maestrami, Eni; M.A. Abu Saif, S.E. Shalaby, M.S. Farhat, Suez Unversity; A.S. Dahab, Cairo University* |
| *1530 hours* | **142501** | **Novel Drilling Technology Delivers a Step Change in Challenging Deepwater Operations** *J. Clausen, J.E. Rebellon, J. Blanc, S.P. Barton, National Oilwell Varco* |
| | Alternate 141957 | **Environmentally Friendly Dispersants for HP/HT Aqueous Drilling Fluids Containing $Mn_3O_4$, Contaminated with Cement, Rock Salt and Clay** *Y. Kar, A.M. Al Moajil, H.A. Nasr El Din, M. Al Bagoury, Texas A&M University; C.D. Steele, Elkem Materials* |
| | Alternate 140957 | **Technical Review of Theory and Application of Pore Pressure Prediction in Deepwater Exploration** *K. Qiu, C. Tan, Y. Chen, Schlumberger* |

## Session Schedule *continued*

*All alternate papers will be presented as posters at specific time slots during coffee breaks. Please refer to the Poster Presentation schedule.*

# Session Nine

**Room 3** — **1400–1600 hours**

**EOR FIELD CASES**

Session Chairpersons: **Mark Beckman**, *ExxonMobil and* **Shehadeh Masalmeh,** *Shell*

| Time | Paper # | Paper Title & Author |
|---|---|---|
| 1400 hours | 140180 | **Successful Field Application of Surfactant Additives to Enhance Thermal Recovery of Heavy Oil**<br>*P. Srivastava, L.U. Castro, Baker Hughes* |
| 1430 hours | 141490 | **Pulsed Neutron Monitoring of the First $CO_2$-EOR Pilot in the Middle East**<br>*F. Al Aryani, A. Obeidi, ADCO; J.V. Brahmakulam, R. Ramamoorthy, Schlumberger* |
| 1500 hours | 141557 | **Numerical Interpretation of Single Well Chemical Tracer Tests for ASP Injection**<br>*A.H. De Zwart, W. M. Stoll, P.M. Boerrigter, D.W. Van Batenburg, Shell; S. S. A. Al-Harthy, Petroleum Development Oman* |
| 1530 hours | 141091 | **Single-Well In-Situ Measure of Oil Saturation Remaining in Carbonate after an EOR Chemical Flood**<br>*J.E. Edwards, R. Ramamoorthy, E. Harrigan, Schlumberger; M. Singh, H. Soek, J.N. Van Wunnik, M. Al Yarabi; Petroleum Development Oman; R.A. Al Mjeni, Shell* |

# Session Ten

**Room 4** — **1400–1600 hours**

**ROCK AND FLUID CHARACTERISATION - 1**

Session Chairpersons: **Adel H. Malallah**, *Kuwait University, and* **Ali Meshari**, *Saudi Aramco*

| Time | Paper # | Paper Title & Author |
|---|---|---|
| 1400 hours | 141539 | **Low Silicate Concentrations Accurately Quantified in Carbonates Using Combined Outputs from Geochemical Well Logs**<br>*E.A. Clerke, C.M. Bradford, Saudi Aramco; R.R. Pemper, F. Mendez, M.W. Bruner, J. Longo, Baker Hughes* |
| 1430 hours | 141241 | **EoS Modelling for Two Major Kuwaiti Oil Reservoirs**<br>*P.C. Tybjerg, C.P. Rasmussen, J. Shaikh, Calsep A/S; M. Al Ajmi, Kuwait Oil Company* |
| 1500 hours | 141783 | **Utilising NMR and Formation Pressure Testing While Drilling to Place Water Injectors Optimally in a Field in Saudi Arabia**<br>*D.A. Al Shehri, M. Kanfar, Saudi Aramco; C.C. Chew, Y.S. Al Ansari, A. Syed, Baker Hughes* |

## Session Schedule *continued*

*All alternate papers will be presented as posters at specific time slots during coffee breaks. Please refer to the Poster Presentation schedule.*

# Session Eleven

***Room 5*** — **1400–1600 hours**

**RESERVOIR MANAGEMENT**

Session Chairpersons: **Mohamed Wael Helmy**, *ExxonMobil and* **Vipin Gupta**, *Petroleum Development Oman*

| Time | Paper # | Paper Title & Author |
|---|---|---|
| *1400 hours* | | Keynote Speaker:<br>**Ganesh Thakur**<br>*2012 SPE President; Vice President , Global Advisor & Chevron Fellow, Chevron Energy Technology Company* |
| *1430 hours* | 142622 | **Achieving Excellence in Well Completion Projects in Iraq's South Oilfields**<br>*G. Aliwi, H.H. Qutob, L. Al Hashmy, S.E. El Salfawi, Weatherford* |
| *1500 hours* | 141110 | **Automating Well Performance Monitoring of Real-Time Data**<br>*A.S. Al Nuaim, G.M. Williamson, M.M. Labban, S. Husan, Saudi Aramco; K.R. Holdaway, S. Krug, SAS Institute* |
| *1530 hours* | 142497 | **Advanced History Matching Techniques Reviewed**<br>*R.W. Rwechungura, J. Kleppe, Norwegian University of Science & Technology; M. Dadashpour, Statoil* |

# Session Twelve

***Room 6*** — **1400–1600 hours**

**RESERVOIR MODELLING - 1**

Session Chairpersons: **François Michel Colomar,** *Beicip Franlab*

| Time | Paper # | Paper Title & Author |
|---|---|---|
| *1400 hours* | | Keynote Speaker:<br>**Professor Hamdi Tchelepi**<br>*Associate Professor, Energy Resources Engineering*<br>*and Co-Director, Center for Computational Earth and Environmental Sciences (CEES)*<br>*Stanford University* |
| *1430 hours* | 140847 | **Efficient Reservoir Simulation Post Processing**<br>*R.J. Frost, N.R. Talbot, Roxar Incorporated; A.M. Al Darrab, O. Hajjar, Saudi Aramco* |
| *1500 hours* | 140666 | **Modelling Naturally Fractured Tight Carbonate Reservoirs - A Case Study**<br>*S. Chakraborty, H. Stelzer, Schlumberger; S. R. Narahari, N. H. Al-Ajmi, S. Al-Ashwak, V. K. Kidambi, C. Pattnaik, Kuwait Oil Company* |
| *1530 hours* | 142535 | **Streamline Simulation of $CO_2$ Storage in Saline Aquifers**<br>*O. H. Saadawi, ADNOC; G. E. Pickup, M. Jin, E. J. Mackay, Heriot-Watt University* |

## Session Schedule *continued*

*All alternate papers will be presented as posters at specific time slots during coffee breaks. Please refer to the Poster Presentation schedule.*

# Session Thirteen

*Room 1*

## 1630–1830 hours

### STIMULATION AND PRODUCTIVITY ENHANCEMENT - 3

Session Chairpersons: **Elaine Leith,** *Shell and* **Shalawn K. Jackson,** *ExxonMobil*

| Time | Paper # | Paper Title & Author |
|---|---|---|
| 1630 hours | 142637 | **While Drilling Mobility and Distributed Temperature Profiles Applied to Matrix Stimulation of a Giant Carbonate Oilfield: A Case Study** *M. A. Dhufairi, Saudi Aramco; N. Orban, D. Ahmed, A. Ebrahim, D. Kalinin, F. Baez, Schlumberger* |
| 1700 hours | 141993 | **Experimental Evaluation of Viscoelastic Surfactant Acid Diversion for Carbonate Reservoirs: Parameters and Performance Analysis** *M. A. Al-Otaibi, G. A. Al-Muntasheri, Saudi Aramco; I. A. Hussein, King Fahd University of Petroleum & Minerals; F. F. Chang, Schlumberger* |
| 1730 hours | 141664 | **Effect of Emulsifier Concentration and Acid Volume Fraction on the Elastic Properties of Emulsified Acids** *M.A. Sayed, H. Nasr El Din, Texas A&M University* |
| 1800 hours | 141339 | **Optimisation of Conventional Acid Jobs and the Historical Trend Leading to Multistage Acid Fracturing Stimulation to Increase Gas-Condensate Productivity in Carbonate Reservoirs in Saudi Arabia** *C.A. Franco, Ecopetrol; R. Solares, K.A. Asiri, N. Al-Shammari, E.A. Alabbad, F.A. Gomez, Saudi Aramco* |
| | Alternate 140167 | **Measuring the Reaction Rate of Lactic Acid with Calcite Using the Rotating Disk Apparatus** *A.I. Rabie, H.A. Nasr El Din, Texas A&M University* |

# Session Fourteen

*Room 2*

## 1630–1830 hours

### RESERVES AND ECONOMICS

Session Chairpersons: **Ibrahim Nashawi,** *Kuwait University and* **Robert G. Meyling,** *Petroleum Development Oman*

| Time | Paper # | Paper Title & Author |
|---|---|---|
| 1630 hours | | **Keynote Speaker:** **Ganesh Thakur** *2012 SPE President; Vice President, Global Advisor & Chevron Fellow* *Chevron Energy Technology Company* |
| 1700 hours | 141368 | **A Methodology to Determine both the Technically Recoverable Resource and the Economically Recoverable Resource in an Unconventional Gas Play** *H.S. Al Madani, Saudi Aramco; S.A. Holditch, Texas A&M University* |
| 1730 hours | 141045 | **New Sec Rules: What is New for the Petrophysicist?** *J.C. Glorioso, A.J. Rattia, Repsol* |
| 1800 hours | 141176 | **Reserves Management System - Rapid Tool for Optimising and Tracking the Growth of Hydrocarbon Resources and Reserves** *M.A. Al Bahar, D.S. Kamal, H.I. Almayyan, A. Bora, Kuwait Oil Company* |
| | Alternate 140538 | **Adopting Simple and Advanced Genetic Algorithms as Optimisation Tools for Increasing Oil Recovery and NPV in an Iraq Oilfield** *W.J. Al Mudhafer, South Oil Company Iraq; M.A. Shahed, University of Manchester* |



***Subject to change.*** *Changes after 6 June 2011 will be reflected in the Conference Programme.*

## Session Schedule *continued*

*All alternate papers will be presented as posters at specific time slots during coffee breaks. Please refer to the Poster Presentation schedule.*

# Session Fifteen

*Room 3* — **1630–1830 hours**

**EOR LAB INVESTIGATIONS**

Session Chairpersons: **Robin Gupta,** *ExxonMobil*

| Time | Paper # | Paper Title & Author |
|---|---|---|
| *1630 hours* | | **Keynote Speaker:** **S.M. Farouq Ali** *Consultant, PERL Canada Limited* |
| *1700 hours* | 139582 | **Experimental and Simulation Study on Use of Surfactant and De-Emulsifier Blend Additives in Steam Flood as EOR Technique in Heavy Oil Reservoir** *O.M. Tiamiyu, F.H. Boukadi, University of Louisiana at Lafayette* |
| *1730 hours* | 141614 | **Experimental Study of $CO_2$ and Methane-Foam Using Carbonate Core Material at Reservoir Conditions** *M.G. Aarra, P. Ormehaug, A. Skauge, UNI CIPR; S.K. Masalmeh, Shell* |
| *1800 hours* | 139537 | **Plans for Chemical Enhanced Oil Recovery in a North Oman Carbonate Field** *H. Soek, M. Jaboob, M. Singh, A. Jabri, K. Al-Harthy, J. Van Wunnik, Petroleum Development Oman; M. Stoll, R. Al-Mjeni, R. Faber, Shell* |
| | Alternate 141205 | **Effect of Surfactants on Water Imbibition into Heterogeneous Carbonate Rocks at Elevated Temperature** *M. Han, A.B. Fuseni, A.A. Yousef, S.L. Kokal, S. Al Saleh, Saudi Aramco* |
| | Alternate 138350 | **First Contact Miscible, Vaporising - and Condensing-Gas Drive Processes in a Channelling Heterogeneity System** *Y.M. Al Wahaibi, Sultan Qaboos University; A.K. Al Hadhrami, Petroleum Development Oman* |

# Session Sixteen

*Room 4* — **1630–1830 hours**

**ROCK AND FLUID CHARACTERISATION - 2**

Session Chairpersons: **Moustafa Oraby**, *Halliburton and* **Sultan M. Al Merikhi**, *GDF Suez Qatar Block 4 Company*

| Time | Paper # | Paper Title & Author |
|---|---|---|
| *1630 hours* | 141843 | **Kidan Sour Gas - Close Upstream Collaboration between Shell and Saudi Aramco Leads to Improved Understanding of a Complex Sour Gas Field** *A. Briner, G. C.J. Holstege, K. Al-Nasser, E. Daou, P. Wood, South Rub Al-Khali Company* |
| *1700 hours* | 141633 | **Quantification of Remaining Oil Saturation Using a New Wireline Dielectric Dispersion Measurement - A Case Study from Dukhan Field Arab Reservoirs** *I. Al Qarshubi, A. Trabelsi, M. Akinsanmi, Qatar Petroleum; R.K. Polinski, O. Faivre, M. Hizem, L. Mosse, Schlumberger* |
| *1730 hours* | 141277 | **Advanced Mud Logging (AML) Aids Formation Evaluation and Drilling, and Yields Precise Hydrocarbon Fluid Composition** *T. Loermans, C. Bradford, Y. Meridji, A. Marsala, Saudi Aramco; F. Kimour, R. Karoum, P. Kasprzykowski, K. Bondabou, Schlumberger* |
| *1800 hours* | 141522 | **Fluid Characterization, A Case Study of a Field with Compositional Gradient** *M. A. Kalehbasti, J. R. Paroodbari,NIOC; R. R. Ravari, University of Stavanger; and M. Amani, Texas A&M University at Qatar* |

## Session Schedule *continued*

*All alternate papers will be presented as posters at specific time slots during coffee breaks. Please refer to the Poster Presentation schedule.*

# Session Seventeen

| Room 5 | | 1630–1830 hours<br>**RESERVOIR DEVELOPMENT** |
|---|---|---|
| | | Session Chairpersons: **Ali Muallem,** *Saudi Aramco and* **K. Kumar**, *Bahrain Petroleum Company* |
| *Time* | *Paper #* | *Paper Title & Author* |
| *1630 hours* | **141553** | **Identifying Minor Faults and Demarcating Compartments in Areas of Large Seismic Anomalies Using Time Lapse OWC Mapping - Example from the Super Giant Greater Burgan Field, Kuwait**<br>*H.S. Al Enezi, J. Bardalaye, K. Al Azmi, A. Aqeel, J. Al Humoud, S.M. Al Haddad, D. Belal, Kuwait Oil Company* |
| *1700 hours* | **141649** | **Integrated Well and Reservoir Surveillance in the PDO EOR Projects**<br>*M. Zwaan, D. Horstmann, J.L. Lopez, J. Ita, T. Sorop, Shell; R. Hartmans, J.S. Saluja, G. Rocco, F. Saadi, S. Schoofs, Petroleum Development Oman* |
| *1730 hours* | **141335** | **Optimum Subsurface Production Management, Abu Dhabi, UAE**<br>*M.M. Kenawy, A.B. Al Katheeri, B.A. Stenger, H.H. Hafez, ADCO* |
| *1800 hours* | **139696** | **Production Forecasting in Heterogeneous Reservoirs without Reservoir Simulation**<br>*A.H. Akram, L.A. Camilleri, A. Badr, Schlumberger* |
| | Alternate 141795 | **Maximising Oil Recovery of a Thin Oil Rim through an Optimised Field Development Plan**<br>*S.V. Garimella, J.M. Harris, A. Kalbani, A. Al Lamki, K. Khabouri, Petroleum Development Oman* |
| | Alternate 142650 | **Strategies to Conduct Steam Injection in Waterflooded Light Oil Reservoir and a Case in Fuyu Reservoir, Jilin**<br>*Z. Xin, W. Yongbin, Z. Baiming, Z. Xianbao, China National Petroleum Corporation; S. Yu, China Petroleum & Chemical Corporation; G. Panqing, University of Wyoming* |

# Session Eighteen

| Room 6 | | 1630–1830 hours<br>**RESERVOIR MODELLING - 2** |
|---|---|---|
| | | Session Chairpersons: **Ahmed El-Banbi,** *Cairo University and* **Mahmood Amani**, *Texas A&M University at Qatar* |
| *Time* | *Paper #* | *Paper Title & Author* |
| *1630 hours* | **141766** | **Compositional Modelling of Heterogeneous Anisotropic Naturally Fractured Reservoirs Using Control Volume Mixed Finite Element Technique**<br>*O. Al-Nahdi, Saudi Aramco; H. Kazemi, Colorado School of Mines* |
| *1700 hours* | **142464** | **A Better Understanding of Finite Element Simulation for Shale Gas Reservoirs through a Series of Different Case Histories**<br>*V. Sahai, A. Boulis, Object Reservoir* |
| *1730 hours* | **141794** | **Using Streamline and Reservoir Simulation to Improve Water Flood Management**<br>*A.S. Al Zawawi, E.M. Hayder, M. Baddourah, M. Ghazali, M. Abd Karim, W. Hidayat, Saudi Aramco* |
| *1800 hours* | **141659** | **Integrated Workflow for Computer Assisted History Matching on a Channelised Reservoir**<br>*E. Peters, F. Wilschut, O. Leeuwenburgh, P. Van Hooff, O.A. Abbink, TNO* |

## Session Schedule *continued*

*All alternate papers will be presented as posters at specific time slots during coffee breaks. Please refer to the Poster Presentation schedule.*

# Session Nineteen

***Room 1*** — **1330–1530 hours**

CONFORMANCE AND PRODUCTION MANAGEMENT - 1

Session Chairpersons: **Mohammed Doghmi**, *Schlumberger and* **Nawzad R. Khurshid**, *Occidental Oil & Gas*

| *Time* | *Paper #* | *Paper Title & Author* |
|---|---|---|
| *1330 hours* | **141465** | **Robust Multi-Phase Flow Measurement Using Magnetic Resonance Technology**<br>*M. Appel, J. Freeman, Shell; D. Pusiol, Spinlock SRL* |
| *1400 hours* | **142676** | **Asset Optimisation Metrics Card - A Unique Approach to Maximising Production Efficiency**<br>*S.F. Desai, F. Abdulla, A. Khatib, S.P. Sinha, Kuwait Oil Company* |
| *1430 hours* | **140278** | **Management of Asphaltene Deposition in a Giant Carbonate Onshore Oilfield, Abu Dhabi, UAE**<br>*S. Misra, D. Abdallah, M.K. Bazuhair, A.A. Aboukshem, B.A. Stenger, A. Katheeri, ADCO* |
| *1500 hours* | **141733** | **Innovative Technique to Prevent Post Fracturing Water Production Using Relative Permeability Modifiers**<br>*A. Ali, M. Amer, R. Yassine, Halliburton; T. Abdel-Khalek, A. Hamdy, Qarun Petroleum Company* |
| | Alternate 139260 | **Production Allocation in Multi-Layers Gas Producing Wells Using Temperature Measurements (by Gentic Algorithm)**<br>*R. Rabie, A.S. El-Din, A. Daoud, Cairo University, A. Ali, A. Nabet, Technical Petroleum Services* |
| | Alternate 141374 | **Proactive Scale Mitigation Strategies for Simple to Complex Multi-Lateral Producers in a Saudi Arabian Carbonate Field**<br>*K.U. Raju, K. Baruah, N.M. Al Otaibi, F.G. Al Shammari, Saudi Aramco* |

# Session Twenty

***Room 2*** — **1330–1530 hours**

ARTIFICIAL LIFT - 1

Session Chairpersons: **Mark Johnson,** *ExxonMobil and* **Nasser K. Al Mossalli,** *Bahrain Petroleum Company*

| *Time* | *Paper #* | *Paper Title & Author* |
|---|---|---|
| *1330 hours* | **141668** | **Poseidon Gas Handling Technology: A Case Study of Three ESP Wells in the Congo**<br>*L.A. Camilleri, Schlumberger; L. Brunet, E. Segui, Total* |
| *1400 hours* | **139532** | **Effect of Near Wellbore Condition on Electrical Submersible Pump Design**<br>*M. Noui Mehidi, Saudi Aramco* |
| *1430 hours* | **142694** | **Flow Instabilities in Gas Lift Wells with Water Coning**<br>*M. L. Aguilar, E. P. Romero, PEMEX E&P; I.G. Sarabia, Y.V. Fairuzov, Multiphase Engineering and Consulting* |
| *1500 hours* | **142597** | **Effective Utilisation of Variable Speed Drive with Electrical Submersible Pumps Post Oil Production in a Remote Desert Field: Case Study**<br>*R.S. Al Dossary, R.A. Al Khuzayem, M.A. Al Hajri, Saudi Aramco* |

## Session Schedule *continued*

*All alternate papers will be presented as posters at specific time slots during coffee breaks. Please refer to the Poster Presentation schedule.*

# Session Twenty One

***Room 3*** — **1330–1530 hours**

**WELL CONTROL AND STABILITY**

Session Chairpersons:
**M. Emad Abdulaziz,** *LUKSAR - LUKOIL Saudi Arabia Energy and* **Musaed N. J. Al-Awad,** *King Saud University*

| *Time* | *Paper #* | *Paper Title & Author* |
|---|---|---|
| *1330 hours* | 141221 | **Monobore Expandable Liner Extension Deployment Saves Well from Abandonment**<br>*C.F. Stockmeyer, A. Durment, A.S. Ismail, Baker Hughes; M. Lapeira, CEPSA* |
| *1400 hours* | 142099 | **Innovative Chemistry for Drilling Fluid Additives**<br>*J. Zheng, J. Wang, O. Musa, D. Farrar, B. Cockcroft, A. Robinson, R. Gibbison, International Specialty Products* |
| *1430 hours* | 142421 | **Cementing at High Pressure Zones in KSA "Discovering the Mystery Behind the Pipe"**<br>*A. F. Al-Dossary, A. Al-Majed, M. E. Hossain, M. K. Rahman, King Fahd University of Petroleum and Minerals; S. Jennings, R. Bargawi, Saudi Aramco* |
| *1500 hours* | 140781 | **Management of the Disastrous Underground Blowout in South of Iran**<br>*R. AShena, M. Nabaei, Islamic Azad University, B. Taei, NISOC, M. Kamyab, J. Moghadasi, Petroleum University of Technology, A. Roohi, NIDC* |
| | Alternate 140966 | **Solid Expandable Solution for Wellbore Stability in Developing Khafji Offshore Field**<br>*M.A. Saad, T. Sanders, M.W. Harvey, Weatherford; M.A. Qadmani, K. Kumamoto, Al Khafji Joint Operations; H. Hanak, Schlumberger* |
| | Alternate 141752 | **Engineered Particle Size Distribution while Drilling Helped Minimising Wellbore Damage in Sandstone Reservoirs**<br>*M.S. Mohamed, Halliburton* |
| | Alternate 142299 | **Effect of Drill Solids on the Prediction Accuracy of a Viscosity Model**<br>*G. Misra, D.E. Jamison, D. Whitfill, Halliburton* |

# Session Twenty Two

***Room 4*** — **1330–1530 hours**

**UNCONVENTIONAL DRILLING TECHNOLOGIES - 1**

Session Chairpersons: **Hani H. Qutob**, *Weatherford and* **Shaohua Zhou**, *Saudi Aramco*

| *Time* | *Paper #* | *Paper Title & Author* |
|---|---|---|
| *1330 hours* | 140312 | **Hammer Drilling Technology - The Proved Solution to Drill Hard Rock Formations in the Middle East**<br>*P. Vieira, C. Lagrandeur, K. Sheets, Weatherford* |
| *1400 hours* | 141845 | **Underbalanced Drilling (UBD) as a Tool to Test Tight Gas Plays - An Example from the Empty Quarter, Saudi Arabia: Drilling and Reservoir Characterisation Lessons**<br>*Y. Al-Maashari, A. Briner, A. Axon, A. Wevers, South Rub Al-Khali Company* |
| *1430 hours* | 142439 | **Shallowest Horizontal Well Drilled in the Middle East: Challenges and Successes**<br>*A. Dutta, B.M. Al Azmi, Kuwait Oil Company; H. Al Abri, M. Ali, Halliburton* |
| *1500 hours* | 139143 | **Modelling of a Down Hole Pulsating Device**<br>*M. Nagib, I. Solomon, U. Isaac, G. G. Nasr, University of Salford* |

## Session Schedule *continued*

*All alternate papers will be presented as posters at specific time slots during coffee breaks. Please refer to the Poster Presentation schedule.*

# Session Twenty Three

*Room 5*

**1330–1530 hours**

**BASIN MODELLING AND RESERVOIR QUALITY PREDICTION**

Session Chairpersons: **Benoit Loiseau,** *Total and* **Mohammed Badri**, *Schlumberger*

| *Time* | *Paper #* | *Paper Title & Author* |
|---|---|---|
| *1300 hours* | **140474** | **Seeing the Invisible: Predicting Fluid Paths with an Innovative Curvature Attributes**<br>*S.A. Al Dossary, Saudi Aramco* |
| *1400 hours* | **142290** | **Regional Geological Understanding of Offshore Cyprus and Lebanon from Interpretation of Dual Sensor Streamer Data**<br>*T. Sortemos, Bayerngas; C. Skiple, Ø. Lie, C. J. Lowrey, P. H. Semb, Petroleum Geo-Services* |
| *1430 hours* | **142211** | **Recent Advances in Pore Pressure Prediction in Complex Geologic Environments**<br>*A.R. Huffman, J. Meyer, Fusion Petroleum Technologies; R. Gruenwald, J. Buitrago, J. Suarez, C. Diaz, J. M. Munoz, J. Dessay, Repsol* |
| *1500 hours* | **141539** | **Low Silicate Concentrations Accurately Quantified in Carbonates Using Combined Outputs from Geochemical Well Logs**<br>*C.M. Bradford, E.A. Clerke, Saudi Aramco; R.R. Pemper, F. Mendez, J. Longo, M.W. Bruner, Baker Hughes* |

# Session Twenty Four

*Room 6*

**1330–1530 hours**

**RESERVOIR MONITORING AND TESTING - 1**

Session Chairpersons: **Olivier Houze**, *Kappa Engineering and* **Mohamed Wael Helmy**, *ExxonMobil*

| *Time* | *Paper #* | *Paper Title & Author* |
|---|---|---|
| *1330 hours* | | **Keynote Speaker:**<br>**Medhat M. Kamal**<br>*Senior Research Consultant, Chevron Energy Technology Company* |
| | **141572** | **Pressure Transient Testing Under Multiphase Flow Conditions**<br>*Medhat M. Kamal, Y. Pan, Chevron* |
| *1400 hours* | **141832** | **Evolution of Petrophysical Data Management at Saudi Aramco**<br>*T.A. Al Ghamdi, H.A. Al Ali, G. Zahdan, I.M. Nahwi, M. Readean, T.L. Tjan, Saudi Aramco* |
| *1430 hours* | **139216** | **New Methods Enhance the Processing of Permanent-Gauge Data**<br>*O.P. Houze, O.F. Allain, B. Josso, Kappa Engineering* |
| *1500 hours* | **142553** | **An Engineering Approach to Utilise Fibre Optics Telemetry Enabled Coiled Tubing in Well Testing and Sand Stone Matrix Stimulation   First Time in the World**<br>*T. Shaheen, L. Dilling, V. Noya, Schlumberger; M. Abd El Fattah, S. Abd El Rahman, E. Anwar, A. El Refaei, General Petroleum Company* |

## Session Schedule *continued*

*All alternate papers will be presented as posters at specific time slots during coffee breaks. Please refer to the Poster Presentation schedule.*

# Session Twenty Five

***Room 1*** — **1600–1800 hours**

**CONFORMANCE AND PRODUCTION MANAGEMENT - 2**

Session Chairpersons: **Mehdi Z. Samama**, *Repsol YPF and* **Piyush Srivastava**, *Baker Huges*

| Time | Paper # | Paper Title & Author |
|---|---|---|
| 1600 hours | 142617 | **Well and Reservoir Behaviour with Varying Associated Gas/Oil Ratio**<br>*B.A. Lundberg, Petroleum Development Oman* |
| 1630 hours | 137133 | **Method to Improve Thermal EOR Performance Using Intelligent Well Technology - Orion SAGD Field Trial Welldynamics**<br>*H.P. Clark, F.A. Ascanio, C. Van Kruijsdijk, J.L. Chavarria, M.J. Zatka, W. Williams, A. Yahyai, Shell; J. Shaw, M. Bedry, Halliburton* |
| 1700 hours | 141206 | **Measuring the Performance of Corrosion Inhibitors to Prevent Black Powder Formation Using a Novel Quartz Crystal Microbalance Technique**<br>*V. Jovancicevic, S. Ramachandran, K.C. Cattanach, Baker Hughes; A. Sherik, Saudi Aramco* |
| 1730 hours | 141023 | **Heavy Duty Wireline Fishing Operations in a HP/HT Sour Gas Well - A Case Study**<br>*G. Purwagautama, I. Afandi, S. Ghany R., PT Medco E&P Indonesia; J.M. Vincent, Weatherford* |

# Session Twenty Six

***Room 2*** — **1600–1800 hours**

**ARTIFICIAL LIFT – 2**

Session Chairpersons: **Matthew Wisnewski**, *Baker Huges and* **Robert Fleming**, *Halliburton*

| Time | Paper # | Paper Title & Author |
|---|---|---|
| 1600 hours | 141817 | **Alternate Deployed Systems Application Guide**<br>*K.T. Bebak, M.D. Wisnewski, Baker Hughes* |
| 1630 hours | 142526 | **Successful Offshore Deployment of the First Bottom Discharge ESP in Saudi Aramco**<br>*F.A. Shinaiber, A.H. Aborshaid, A.A. Ghamdi, S.A. Jokhio, M.A. Al Dhufairi, Saudi Aramco; R.K. Mofty, Schlumberger* |
| 1700 hours | 141170 | **$H_2S$ Challenges Presented to ESP Systems**<br>*M.A. Sikes, D.L. Adams, J.P. Qi, K. Wonitoy, Baker Hughes* |
| 1730 hours | 141984 | **A New Productivity Index Formula for ESP Lifted Wells**<br>*A.M. Al Gahtani, King Fahd University of Petroleum and Minerals* |
| | Alternate 134344 | **Gas Well Deliquification Using Microwave Heating**<br>*M. Kamal, N. Ghodke, S.D. Patwardhan, F. Al-Dogail, Maharashtra Institute of Technology* |



***Subject to change.*** *Changes after 6 June 2011 will be reflected in the Conference Programme.*

## Session Schedule *continued*

*All alternate papers will be presented as posters at specific time slots during coffee breaks. Please refer to the Poster Presentation schedule.*

# Session Twenty Seven

**Room 3** — **1600–1800 hours**

**FACILITIES**

Session Chairpersons: **Ghaithan A. Al-Muntasheri,** *Saudi Aramco and* **Mohammed Aggour**, *Texas A&M University at Qatar*

| Time | Paper # | Paper Title & Author |
|---|---|---|
| 1600 hours | | **Keynote Speaker:**<br>**Cosan Ayan**<br>*Reservoir Engineering Advisor, Schlumberger*<br>**Facilities and the Reservoir: The Multi-Dimensional Interaction** |
| 1630 hours | 141101 | **Long Term Injectivity Test in a Field Characterised by a Tar Mat Zone Strives to Unlock Higher Reservoir Potential**<br>*J.O. Arukhe, M. Al Dhufairi, S. Al Ghamdi, B. Harbi, Saudi Aramco; P.R. Docherty, Schlumberger* |
| 1700 hours | 141229 | **Online Production Model**<br>*M. Narain, T. Al Nabhan, Kuwait Oil Company* |
| 1730 hours | 140997 | **Mitigating Flow Assurance Challenges in Deepwater Fields Using Active Heating Methods**<br>*M.M. Myo Thant, M.T. Mohd Sallehud-Din, PETRONAS Research; G.F. Hewitt, C.P. Hale, Imperial College London; G.L.Quarini, University of Bristol* |

# Session Twenty Eight

**Room 4** — **1600–1800 hours**

**UNCONVENTIONAL DRILLING TECHNOLOGIES - 2**

Session Chairpersons: **Robert H. Gales,** *Weatherford and* **Rob Buchan,** *GDF Suez Qatar*

| Time | Paper # | Paper Title & Author |
|---|---|---|
| 1600 hours | 140267 | **Integrated Downhole Isolation Valve and Managed Pressure Drilling to Facilitate Development of Sour Fractured Limestone Gas Reservoir in East Java, Indonesia**<br>*G.R. Darmawan, N.B. Sangka, PERTAMINA E&P; S. Nas, J.T. Shaun, S. Toralde, A. E. Prasetia, Sisworo, Weatherford* |
| 1630 hours | 139412 | **A New Approach to Drilling Hard Chert Contaminated Carbonate Formations in Kazakhstan**<br>*H.H. Donald, Smith Bits/Schlumberger* |
| 1700 hours | 142363 | **Enhanced Sustained Production from Successful Underbalanced Coiled Tubing Drilling in Saudi Arabian Deep Tight Gas Sandstone and Carbonate Formations**<br>*A.M. Al-Omair, H. Al Jamaan, Z. Rahim, B.B. Al-Malki, A. Al-Kanaan, Saudi Aramco* |

## Session Schedule *continued*

*All alternate papers will be presented as posters at specific time slots during coffee breaks. Please refer to the Poster Presentation schedule.*

# Session Twenty Nine

*Room 5*

**1600–1800 hours**

**PEOPLE DEVELOPMENT**

Session Chairpersons: **Khalid Omairen**, *Saudi Aramco and* **Zara Z. Khatib,** *Petroleum Institute/Shell*

| Time | Paper # | Paper Title & Author |
|---|---|---|
| 1600 hours | 142667 | **Keynote Speaker:** **Craig W. van Kirk** *Professor, Colorado School of Mines* **Collaboration Models for University and Petroleum Industry Partners with Focus on MENA** |
| 1630 hours | 142646 | **Oil & Gas Competency Management: An Innovative Way to Attract, Develop, Maximize, and Retain Human Capital** *E.Daher, L.J. Gimenez S., J. C. G. Bonilla , Schlumberger* |
| 1700 hours | 141555 | **Systemising People - Systems to Manage People or People to Manage Systems** *N. Ahmed, Baker Hughes* |
| 1730 hours | 141838 | **Challenges in Attracting and Retaining Females in the Oil Industry to Meet a Diverse, Equal, and Inclusive Workforce** *Y. Wafa, Baker Hughes* |

# Session Thirty

*Room 6*

**1600–1800 hours**

**RESERVOIR MONITORING AND TESTING - 2**

Session Chairpersons:
**Abdulaziz A. Al-Majid,** *King Fahd University of Petroleum and Minerals and* **Medhat M. Kamal,** *Chevron*

| Time | Paper # | Paper Title & Author |
|---|---|---|
| 1600 hours | | **Keynote Speaker:** **Fikri J. Kuchuk** *Chief Reservoir Engineer, Schlumberger* |
| 1630 hours | 142510 | **Novel Borehole System for Reservoir Monitoring Using Transient Electromagnetics** *S.M. Dutta, A. Reiderman, L.G. Schoonover, M. Rabinovich, Baker Hughes* |
| 1700 hours | 139587 | **Challenges in Interpreting Well Testing Data from Fractured Water Injection Wells with a Dual Storage Phenomenon** *S.A. Bin Akresh, N.M.A. Rahman, Saudi Aramco* |
| 1730 hours | 140790 | **A Successful Introduction of a New Tools Configuration and Analysis Method for Production Logging in Horizontal Wells** *J. Torne, F. Arevalo, P.L. Jay, M. Eid, N. Guergueb, G. Frisch, Halliburton* |
| | Alternate 142669 | **Deploying a Wireless Downhole Reservoir Testing System Enabling Real-Time Interpretation and Tool Control** *A. A. Al-Nahdi, R. Saleh, Saudi Aramco; A. Omidiya, M. Loth, F. Mabrouki, E. Lemenager, Schlumberger* |
| | Alternate 142682 | **Drill-Stem Test with Real Time Reservoir Data Monitoring Improves Operational Efficiency - Case Study, Senoro-6** *D. H. Febrianto, F. D. Rachmawati, Medco Energy; A. Khan, J. Haddad, A. Salguero, Halliburton* |

## Session Schedule *continued*

*All alternate papers will be presented as posters at specific time slots during coffee breaks. Please refer to the Poster Presentation schedule.*

# Session Thirty One

**Room 2** — **0800–1000 hours**

**GEOMECHANICS**

Session Chairpersons: **Edwin Jong**, *Baker Hughes and* **Younane N. Abousleiman**, *University of Oklahoma*

| Time | Paper # | Paper Title & Author |
|---|---|---|
| 0800 hours | 141670 | **Use of Improved Gridding Technique in Coupled Geomechanics and Compositional Reservoir Flow Simulation**<br>*V.K. Shrivastava, D. Tran, L.X. Nghiem, B.F. Kohse, Computer Modelling Group* |
| 0830 hours | 141371 | **Reservoir Optimised Fracturing-Higher Productivity from Low-Permeability Reservoirs through Customised Multistage Fracturing**<br>*T. Finkbeiner, H. Freitag, M. Siddiqui, R. Woudwijk, K. Joseph, F. Amberg, Baker Hughes* |
| 0900 hours | 142022 | **The Role of Geomechanics in Diagnosing Drilling Hazards and Providing Solutions to the Northern Iraq Fields**<br>*I. Abalioglu, A.S. Genel Enerji, H. Legarre, B. Sallier, Addax Petroleum; J. Gao, M. van Galen, Q. Chou, B. Neil, H. Soroush, H. Qutob, Z. Mahli, Weatherford* |
| 0930 hours | 140949 | **Thermal-Poro Elastic Stress Effect on Stress Reorientation in Production and Injection Wells**<br>*A.S. Abou Sayed, Advantek International; Z. Zhai, University of Texas at Austin* |
| | Alternate 141863 | **Identifying Stress Transfer in CSS Reservoir Operations through Integrated Microseismic Solutions**<br>*M. Prince, A. Baig, T. Urbancic, Engineering Seismology Group* |
| | Alternate 138841 | **Prediction of Poisson's Ratio and Young's Modulus for Hydrocarbon Reservoirs Using Alternating Conditional Expectation Algorithm**<br>*B.D. Al Anazi, M. Tale, M. Al Garni, I. Al-Mushigeh, King Abdulaziz City for Science and Technology* |

# Session Thirty Two

**Room 3** — **0800–1000 hours**

**I-FIELD**

Session Chairpersons: **Medhat M. Kamal**, *Chevron and* **Saeed Mubarak**, *Saudi Aramco*

| Time | Paper # | Paper Title & Author |
|---|---|---|
| 0800 hours | | **Keynote Speaker:**<br>**Professor Iraj Ershaghi**<br>*O.B. Milligan Professor and Director, Petroleum Engineering Program*<br>*University of Southern California* |
| 0830 hours | 141874 | **Intelligent Fields: Industry's Frontier and Opportunities**<br>*T.A. Al Dhubaib, Saudi Aramco* |
| 0900 hours | 141771 | **Real-Time Operations Portal (Nibras): Another Step En Route to a Smart Field Management**<br>*S. Shihab, S. Khaduri, S. Busaidy, S. Bettembourg, Petroleum Development Oman* |
| 0930 hours | 141741 | **Mitigating Compaction Damage through Real-Time Strain Monitoring at the Sandface**<br>*D. M. Earles, C. W. Stoesz, Baker Hughes; J.G. Pearce, H. A. DeJongh, Shell* |

## Session Schedule *continued*

*All alternate papers will be presented as posters at specific time slots during coffee breaks. Please refer to the Poster Presentation schedule.*

# Session Thirty Three

***Room 1***

## 1030–1230 hours

### UNCONVENTIONAL TECHNOLOGIES IN E&P: A CANDID REACH TO OTHER FIELDS

Session Chairpersons: **Adel Al-Abbasi,** *Kuwait Oil Company and* **Adel Malallah,** *Kuwait University*

Researchers from outside the E&P are making big strides in their own fields resolving great challenges that the Oil and Gas industry could learn and benefit from. E&P knew of few readily available solutions that it adopted (or in the process of adopting) to its operations. However, there are yet many unmarked innovations with enabling micro-/nano-technologies in life sciences and medicine, material science and chemical industries, aerospace and defense, etc. that the E&P will need to know about, adopt and adapt, to its own use and benefit. The session tags team domain experts from these outside disciplines with E&P "rapporteurs" to help the audience better assimilate the issues with an E&P perspective and relevance.

**Keynote Speakers:**

**Mazen Y. Kanj**
*PE Specialist*
*Saudi Aramco*

**Professor Metin Sitti**
*Associate Professor, Mechanical Engineering*
*Carnegie Mellon University*

**Professor Roland N. Horne**
*Professor, Energy Resources*
*Stanford University*

| | |
|---|---|
| 142592 | **Industry First Field Trial of Reservoir Nanoagents**<br>*M.Y. Kanj, Saudi Aramco; M. H. Rashid, E. P. Giannelis, Cornell University* |

# Session Thirty Four

***Room 2***

## 1030–1200 hours

### EXTENDED REACH AND GEOSTEERING

Session Chairpersons: **Ehab Nagm**, *Halliburton and* **Menour J. Al Shammari,** *Kuwait Oil Company*

| *Time* | *Paper #* | *Paper Title & Author* |
|---|---|---|
| *1030 hours* | 142671 | **Automatic Trajectory Control in Extended Reach Wells**<br>*C. Cockburn, J. Matheus, K.L.P. Dang, Schlumberger* |
| *1100 hours* | 142420 | **Geosteering Improvement with a Telemetry Model**<br>*A. Hartmann, O. Akimov, C. Fulda, S.A. Morris, Baker Hughes* |
| *1130 hours* | 142145 | **Universal Technique Normalises and Plans Various Well Paths for Directional Drilling**<br>*X. Liu, Sinopec Research Institute of Petroleum Engineering* |



***Subject to change.*** *Changes after 6 June 2011 will be reflected in the Conference Programme.*

## Session Schedule *continued*

*All alternate papers will be presented as posters at specific time slots during coffee breaks. Please refer to the Poster Presentation schedule.*

# Session Thirty Five

| Room 3 | | 1030–1230 hours<br>ENVIRONMENT AND RISK MANAGEMENT |
|---|---|---|
| | | Session Chairpersons: **Mehdi Z. Samama**, *Repsol YPF and* **Omar ElMansuri**, *Akakus Oil Operations* |
| *Time* | *Paper #* | *Paper Title & Author* |
| *1030 hours* | 142587 | **Risk Analysis Tool Applied to Understand the Possible Negative Environmental Effects of Unlined Drilling Pits in Desert Environments**<br>*G. Carrillo, Repsol YPF; M.J. Rubial, WorleyParsons; S. Firth, Firth Consultants* |
| *1100 hours* | 139680 | **A Comprehensive look at the CRI Project Pilot Test in KSA**<br>*A. F. Al-Dossary, I, Ahmad, M. Al-Ghamdi, A. Al-Hendi, H. Al-Haj, Saudi Aramco* |
| *1130 hours* | 140692 | **Application of a New Multi Laterolog Logging Tool in the Phiops Field of Egypt, A Case Study**<br>*H. Maurer, R. Khokhar, B. Corley, Baker Hughes; T. Abdel Shafy, A. Fattah, Khalda Petroleum Company* |

# Session Thirty Six

| Room 4 | | 1030–1200 hours<br>EXPLORATION METHODS |
|---|---|---|
| | | Session Chairpersons:<br>**Abdullatif Al-Shuhail,** *King Fahd University of Petroleum and Minerals and* **Anwar Khalaf**, *Bahrain Petroleum Company* |
| *Time* | *Paper #* | *Paper Title & Author* |
| *1030 hours* | 140705 | **Accelerating Interactive Seismic Applications Using Fast Sorting Algorithm**<br>*S. Al-Dossary, A.S. Al-Sharikh, Saudi Aramco* |
| *1100 hours* | 140467 | **Identifying Reservoir Heterogeneity of the Ratawi Limestone in Umm Gudair Field, Kuwait; Utilising Seismic Attributes and Post Stack Inversion: A Case Study**<br>*P. Dutta, H.R. Al Muraikhi, Kuwait Oil Company* |
| *1130 hours* | 140692 | **Application of a New Multi Laterolog Logging Tool in the Phiops Field of Egypt, A Case Study**<br>*H. Maurer, R. Khokhar, B. Corley, Baker Hughes; T. Abdel Shafy, A. Fattah, Khalda Petroleum Company* |

## Session Schedule *continued*

*All alternate papers will be presented as posters at specific time slots during coffee breaks. Please refer to the Poster Presentation schedule.*

# Session Thirty Seven

**Room 5** — **1030–1230 hours**

**ADVANCED COMPLETION SYSTEMS**

Session Chairpersons: **Steve Dyer,** *Schlumberger*

| Time | Paper # | Paper Title & Author |
| --- | --- | --- |
| 1030 hours | | **Keynote Speaker:** **Mark Johnson** *Senior Artificial Lift Consultant, EMPC Subsurface Engineering & Operations Support, ExxonMobil* **Optimum Completion Designs for the LIfe of the Well** |
| 1100 hours | 141540 | **World's First Hybrid Inflow Control Completion in India's Largest Onshore Oilfield** *T. McKenzie, A.D. Wenk, Cairn India; P. Khan, P. Gavioli, C.P. Andrew, Baker Hughes* |
| 1130 hours | 140696 | **Smart Combination of Technology Tools Resulted in Successful Rigless Stimulation on a Tri-Lateral Well: Case Study** *A.K. Al Zain, A.A. Al Gamber, R. Said, Saudi Aramco* |
| 1200 hours | 140970 | **To ICD or Not to ICD? A Techno-Economic Analysis of Different Control Strategies Applied to a Thin Oil Rim Field Case** *A. Twerda, E.D. Nennie, G. Alberts, A.P. Leemhuis, C. Widdershoven, TNO* |
| | Alternate 142410 | **Design, Completion and Optimisation of High Pressure/High Rate Offshore Gas Wells** *E.A. Uzcategui, A.S. Ahmari, Saudi Aramco* |
| | Alternate 142361 | **Enhancement of Oil Recovery through "Dump Flood" Water Injection Concept in Satellite Field** *W. Shizawi, H. Subhi, A. Al Rashidi, A. Dey, F. Fathiya, M. Aisary, Petroleum Development Oman* |

# Session Thirty Eight

**Room 6** — **1030–1200 hours**

**BUSINESS MODEL**

Session Chairpersons: **Adel Al-Naji,** *Saudi Aramco and* **Charles J. Mart**, *ExxonMobil*

| Time | Paper # | Paper Title & Author |
| --- | --- | --- |
| 1030 hours | 140202 | **Unified, Automated and Map Based E&P Data Management** *S.S. Waked, Y. Al-Ghamdi, A.A. Al Zahrani, Y. Radhi, Saudi Aramco* |
| 1100 hours | 141401 | **Smart E&P Collaboration Centers: Design, Technology Support and Lessons Learned** *A.A. Al Qahtani, M.F. Hogg, K.K. Lau, N.A. Naser, Saudi Aramco* |
| 1130 hours | 139885 | **Contractor HSE Management via Effective Mitigation of Risk in the Tendering Process** *G.M. Abou elkhair, A.Y. Al Haidar, Kuwait Oil Company* |

# Poster Presentations

Hall 2

Posters will be on display throughout the conference. Posters will be presented at specific time slots during coffee breaks, as indicated in the schedule below. Conference delegates are encouraged to visit the poster presentations to meet authors in an informal and interactive environment for technical exchange.

**Technical Discipline Key:**

| PRODUCTION AND OPERATIONS | RESERVOIR ENGINEERING | DRILLING AND COMPLETIONS | EXPLORATION | SPECIAL TOPICS | ENVIRONMENT AND RISK MANAGEMENT |
|---|---|---|---|---|---|

## Monday, 26 September 2011

**PRODUCTION AND OPERATIONS**

| *Time* | *Paper #* | *Poster Title & Authors* |
|---|---|---|
| 1010-1020 hours | 141021 | **Evolution of Coiled Tubing Matrix Stimulation for Gas Wells in Saudi Arabia**<br>*M. Al-Atwi, J. R. Solares, R. Amorocho, F. Garzon, Saudi Aramco; W. Kharrat, J. Stuker, I. Naji, Schlumberger* |
| | 141639 | **Perforating Long Horizontal Section with Tractor Brings Significant Gains in Completion Efficiency**<br>*M. Badri A. Al-Hashami M. Al-Masroori PDO; A. Salsman M. S. Jumaat H. Situmorang Schlumberger* |

**RESERVOIR ENGINEERING**

| *Time* | *Paper #* | *Poster Title & Authors* |
|---|---|---|
| 1010-1020 hours | 139782 | **Analysis of "Lower limit Formation" in Low Permeability Sands of Ordos Basin**<br>*L. Xiao, Z. Mao, China University of Petroleum; Y. Shi, H. Guo, PetroChina* |
| | 140971 | **NMR Stabilization and Relaxation in a Single Pass Provides Reservoir Solutions**<br>*C. Smith, S. Ramakrishna, E. Menendez, Halliburton* |

**DRILLING AND COMPLETIONS**

| *Time* | *Paper #* | *Poster Title & Authors* |
|---|---|---|
| 1010-1020 hours | 141486 | **New PDC Technology Improves Drilling Performance and Sets New Penetration Record in Rageshwari Field, Rajasthan, India**<br>*A. Upadhaya, Cairn Energy India; A.R. Chowdhury, R. Borgaonkar, Baker Hughes;* |
| | 141673 | **Adjustable Gauge Stabiliser and Torque and Drag Reduction Tools Reduce Overall Drilling Times by at Least 20%: A Case Study**<br>*J.E. McCormick, G. Osorio, Weatherford; M.E. Barth, University of Texas at Austin; J. H. Andachi, EP Petroecuador* |

**PRODUCTION AND OPERATIONS**

| *Time* | *Paper #* | *Poster Title & Authors* |
|---|---|---|
| 1020-1030 hours | 141054 | **Field Application of Chemically Treated Substrate in Pre-Packed Well Screen**<br>*J.B. Weirich, T.D. Monroe, B.B. Beall, A.K. Singh, D. Gupta, Baker Hughes; J. McBee, Nippon Oil Exploration* |
| | 142700 | **Inflow Control Devices Minimises Annular Velocity in Gas Wells with Standalone Screen Completions**<br>*R.E. Regulacion, N. Shahreyar Halliburton* |
| | 140207 | **An Economic Evaluation Model (EEM) for Selecting Sand Management Technology**<br>*B. Dong, L. Ren, China National Petroleum Corporation; X. Wu, China University of Petroleum Beijing* |

## Monday, 26 September 2011 *continued*

**RESERVOIR ENGINEERING**

| Time | Paper # | Poster Title & Authors |
|---|---|---|
| 1020-1030 hours | 140960 | **The Modification of the Dykstra-Parsons Method for Inclined Stratified Reservoirs**<br>*N. A. F. El-Khatib, Universiti Teknologi PETRONAS* |
| | 142489 | **Effects of Block to Block Interaction on Oil Recovery from South Pars Oil Layer**<br>*R. R. Sani, M. Afsari, Iranian Offshore Oil Company (IOOC), M. Amani, Texas A&M University at Qatar* |
| | 142618 | **Modelling the Oil Bank Formation During Steam Flood**<br>*A.F. Alajmi, Kuwait University* |

**PRODUCTION AND OPERATIONS**

| Time | Paper # | Poster Title & Authors |
|---|---|---|
| 1610-1620 hours | 141681 | **After Closure Analysis an Underutilised and Undervalued Approach to Understanding kh**<br>*M. Rylance, BP Exploration, T. Judd, A. Makmun, Schlumberger* |

**DRILLING AND COMPLETIONS**

| Time | Paper # | Poster Title & Authors |
|---|---|---|
| 1610-1620 hours | 141957 | **Environmentally Friendly Dispersants for HP/HT Aqueous Drilling Fluids Containing Mn3O4, Contaminated with Cement, Rock Salt and Clay**<br>*Y. Kar, A.M. Al Moajil, H.A. Nasr El Din, M. Al Bagoury, Texas A&M University; C.D. Steele, Elkem Materials* |
| | 140957 | **Technical Review of Theory and Application of Pore Pressure Prediction in Deepwater Exploration**<br>*K. Qiu, C. Tan, Y. Chen, Schlumberger* |

**RESERVOIR ENGINEERING**

| Time | Paper # | Poster Title & Authors |
|---|---|---|
| 1610-1620 hours | 141091 | **Single-Well In Situ Measure of Oil Saturation Remaining in Carbonate after an EOR Chemical Flood**<br>*J.E. Edwards,R. Ramamoorthy, E. Harrigan, Schlumberger; M. Singh, H. Soek, J.N. Van Wunnik, M. Al Yarabi; Petroleum Development Oman; R.A. Al Mjeni, Shell* |

**PRODUCTION AND OPERATIONS**

| Time | Paper # | Poster Title & Authors |
|---|---|---|
| 1620-1630 hours | 140167 | **Measuring the Reaction Rate of Lactic Acid with Calcite Using the Rotating Disk Apparatus**<br>*A.I. Rabie, H.A. Nasr El Din, Texas A&M University* |

**RESERVOIR ENGINEERING**

| Time | Paper # | Poster Title & Authors |
|---|---|---|
| 1620-1630 hours | 140538 | **Adopting Simple and Advanced Genetic Algorithms as Optimisation Tools for Increasing Oil Recovery and NPV in an Iraq Oilfield**<br>*W.J. Al Mudhafer, South Oil Company Iraq; M.A. Shahed, University of Manchester* |
| | 138350 | **First-Contact-Miscible, Vaporising - and Condensing-Gas Drive Processes in a Channelling Heterogeneity System**<br>*Y.M. Al Wahaibi, Sultan Qaboos University; A.K. Al Hadhrami, Petroleum Development Oman* |
| | 141205 | **Experimental Study on Tertiary CO2 WAG Under Immiscible, Near Miscible and Miscible Conditions**<br>*L. Nuryaningsih, H. Jiang, H. Adidharma, University of Wyoming* |
| | 141659 | **Integrated Workflow for Computer Assisted History Matching on a Channelised Reservoir**<br>*E. Peters, F. Wilschut, O. Leeuwenburgh, P. Van Hooff, O.A. Abbink, TNO* |
| | 141795 | **Maximising Oil Recovery of a Thin Oil Rim through an Optimised Field Development Plan**<br>*S.V. Garimella, J.M. Harris, A. Kalbani, A. Al Lamki, K. Khabouri, Petroleum Development Oman* |
| | 142621 | **Ensemble-Based Water Flooding Optimisation Applied to Mature Fields**<br>*O. Pajonk, R. Schulze-Riegert, M. Krosche, SPT Group, H. Mustafa, M. Nwakile, Clausthal University of Technology* |
| | 142650 | **Strategies to conduct steam Injection in Waterflooded Light Oil Reservoir and a Case in Fuyu Reservoir, Jilin**<br>*Z. Xin, W. Yongbin, Z. Baiming, Z. Xianbao, China National Petroleum Corporation; S. Yu, SINOPEC; G. Panqing, University of Wyoming;* |

# Poster Presentations *continued*

**Hall 2**

## Tuesday, 27 September 2011

**PRODUCTION AND OPERATIONS**

| Time | Paper # | Poster Title & Authors |
|---|---|---|
| 1010-1020 hours | 139260 | **Production Allocation in Multi-Layers Gas Producing Wells Using Temperature Measurements (by Gentic Algorithm)**<br>*R. Rabie, A. S. El-Din, A. Daoud, Cairo University; A. Ali, A. Nabet, Technical Petroleum Services* |
| | 141374 | **Proactive Scale Mitigation Strategies for Simple to Complex Multilateral Producers in a Saudi Arabian Carbonate Field**<br>*K.U. Raju, K. Baruah, N.M. Al Otaibi, F.G. Al Shammari, Saudi Aramco* |

**DRILLING AND COMPLETIONS**

| Time | Paper # | Poster Title & Authors |
|---|---|---|
| 1010-1020 hours | 140966 | **Solid Expandable Solution for Wellbore Stability in Developing Khafji Offshore Field**<br>*M.A. Saad, T. Sanders, M.W. Harvey, Weatherford; M.A. Qadmani, K. Kumamoto, Al Khafji Joint Operations; H. Hanak, Schlumberger* |
| | 141752 | **Engineered Particle Size Distribution While Drilling Helped Minimising Wellbore Damage in Sandstone Reservoirs**<br>*M.S. Mohamed, Halliburton* |
| | 142299 | **Effect of Drill Solids on the Prediction Accuracy of a Viscosity Model**<br>*G. Misra, D.E. Jamison, D. Whitfill, Halliburton* |

**EXPLORATION**

| Time | Paper # | Poster Title & Authors |
|---|---|---|
| 1020-1030 hours | 142211 | **Recent Advances in Pore Pressure Prediction in Complex Geologic Environments**<br>*A. R. Huffman, J. Meyer, Fusion Petroleum Technologies; R. Gruenwald, J. Buitrago, J. Suarez, C. Diaz, J. M. Munoz, J. Dessay, Repsol* |

**PRODUCTION AND OPERATIONS**

| Time | Paper # | Poster Title & Authors |
|---|---|---|
| 1020-1030 hours | 134344 | **Gas Well Deliquification Using Microwave Heating**<br>*M. Kamal, N. Ghodke, S.D. Patwardhan, F. Al-Dogail, Maharashtra Institute of Technology* |

**RESERVOIR ENGINEERING**

| Time | Paper # | Poster Title & Authors |
|---|---|---|
| 1020-1030 hours | 142669 | **Deploying a Wireless Downhole Reservoir Testing System Enabling Real-Time Interpretation and Tool Control**<br>*A. A. Al-Nahdi, R. Saleh, Saudi Aramco; A. Omidiya, M. Loth, F. Mabrouki, E. Lemenager, Schlumberger* |
| | 142682 | **Drill-Stem Test with Real-Time Reservoir Data Monitoring Improves Operational Efficiency - Case Study Senoro-6**<br>*D. H. Febrianto, F. D. Rachmawati, Medco Energy; A. Khan, J. Haddad, A. Salguero, Halliburton* |

## Wednesday, 28 September 2011

**SPECIAL TOPICS**

| Time | Paper # | Poster Title & Authors |
|---|---|---|
| 1010-1020 hours | 138841 | **Prediction of Poisson's Ratio and Young's Modulus for Hydrocarbon Reservoirs Using Alternating Conditional Expectation Algorithm**<br>*B.D. Al Anazi, M. Tale, M. Al Garni, I. Al-Mushigeh, King Abdulaziz City for Science and Technology* |
| | 140949 | **Thermal Poro Elastic Stress Effect on Stress Reorientation in Production and Injection Wells**<br>*A. S. Abou Sayed, Advantek International; Z. Zhai, University of Texas at Austin* |
| | 141863 | **Identifying Stress Transfer in CSS Reservoir Operations Through Integrated Microseismic Solutions**<br>*M. Prince, A. Baig, T. Urbancic, Engineering Seismology Group* |

**ENVIRONMENT AND RISK MANAGEMENT**

| Time | Paper # | Poster Title & Authors |
|---|---|---|
| 1010 - 1020 hours | 142487 | **Drilling Waste Management: A Case Study of the Drilling Waste Management and Environmental Control in One of the Iranian Offshore Fields**<br>*M. Amani, Texas A&M University at Qatar* |
| | 142508 | **Bioremediation of Oily Contaminated Soil through Biostimulation of Indigenous Soil Microbial Community at the Sahara Desert**<br>*E.C. Ercoli, G. Carrillo, Repsol YPF; O. El Mansuri, Akakus Oil Operations* |

**PRODUCTION AND OPERATIONS**

| Time | Paper # | Poster Title & Authors |
|---|---|---|
| 1010-1020 hours | 142361 | **Enhancement of Oil Recovery through "Dump flood" Water Injection Concept in Satellite Field**<br>*W. Shizawi, H. Subhi, A. Al Rashidi, A. Dey, F. Fathiya, M. Aisary, Petroleum Development Oman* |
| | 142410 | **Design, Completion and Optimisation of High Pressure/High Rate Offshore Gas Wells**<br>*E.A. Uzcategui, A.S. Ahmari, Saudi Aramco* |

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# Editorial 2011 Calendar

| Jan/Feb | Mar/Apr | May/Jun | Jul/Aug | Sep/Oct | Nov/Dec |
|---|---|---|---|---|---|
| **Ad Closing:** 4 Jan 2011 **Materials Closing:** 11 Jan 2011 | **Ad Closing:** 1 March 2011 **Materials Closing:** 4 March 2011 | **Ad Closing:** 22 April 2011 **Materials Closing:** 29 April 2011 | **Ad Closing:** 5 July 2011 **Materials Closing:** 12 July 2011 | **Ad Closing:** 29 August 2010 **Materials Closing:** 30 August 2011 | **Ad Closing:** 8 October 2011 **Materials Closing:** 15 October 2011 |
| • Saudi Aramco RTOC<br>• Digitalization<br>• While Drilling Technology<br>• Telemetry<br>• Production<br>• OGEP II Review | • Khurais<br>• Near Surface Modelling<br>• Rotary Steerable & Motor Systems<br>• Drill Bits and Under-reamers<br>• Complex Wells<br>• Geophysical<br>• Drill Pipe Integrity | • Manifa<br>• Remote Operation Centre<br>• Drill-Bit Tech<br>• Inflow Control Devices<br>• Zonal Isolation (incl. Packers,Multi-Zone Completions)<br>• Carbonate Reservoir Heterogenity<br>• Exploration Rub Al Khali | • Formation Evaluation<br>• Wellbore Intervention<br>• Casing While Drilling<br>• Multi-Laterals<br>• Lowering Drilling Costs in Tight Gas<br>• Evaluating Tight Gas Formations<br>•Increasing Productivity of Tight and Shale Gas | • Khursaniyah<br>• Expandable Completions<br>• Tubulars<br>• Logging and Measurement WD<br>• Electrical Submersible Pumps<br>• Progressive Cavity Pumps<br>• Novel Tight Gas Technologies | • Hawiyah<br>• Smart Completions<br>• I field<br>• Geosteering<br>• GOSP<br>• Extended Seismic Feature (4D, OBC, Wide Azimuth) |
| **Issue 18** *'OGEP II Review'* | **Issue 19** *'Innovation, IOC, NOC and Service Company Alliances'* | **Issue 20** *'Upstream Challenges'* | **Issue 21** *'Tight Gas Lowering Costs and Increasing Productivity'* | **Issue 22** *'Cost Effective Drilling and Completions'* | **Issue 23** *'Cooperation, Innovation and Investment'* |
| **BONUS CIRCULATION** | | | | | |
| **SPE/IADC Drilling Conference** 1-3 March 2011 Amsterdam The Netherlands<br><br>**Royal Commission for Yanbu and Jubail Saudi Downstream*** 8-9 March 2011<br><br>**YP Symposium**** 14-16 March 2011 | **Middle East Oil and Gas Show and Conference*** 20-23 March 2011 Manama Bahrain<br><br>**9th Meeting of the Saudi Society for Geosciences**** 26-28 April, 2011 King Saud University Campus, Riyadh | **Offshore Technology Conference** 2-5 May 2011 Houston, Texas, USA<br>**SPE/DGS Annual Technical Symposium & Exhibition*** 15-18 May 2011 Khobar, Saudi Arabia<br><br>**73rd EAGE Conference & Exhibition/SPE EUROPEC** 23-26 May 2011 Vienna, Austria<br>**Brasil Offshore Exhibition Conference** 14-17 June 2011 Macae, Brazil | | **Offshore Europe*** 6-8 Sept 2011 Aberdeen, UK<br>**SPE/EAGE Reservoir Characterization and Simulation Conference** 26-28 Sept 2011 Abu Dhabi, UAE<br>**OTC Brasil** 4-6 Oct 2011 Rio de Janeiro, Brazil<br>**Middle East Drilling Technology Conference and Exhibition** 24-26 Oct 2011 Muscat, Oman | **SPE Annual Technical Conference and Exhibition** 30 Oct - 2 Nov 2011 Denver Colorado, USA<br>**International Petroleum Technology Conference** 15-17 Nov 2011 Bangkok, Thailand<br>**20th World Petroleum Congress*** 4-8 December 2011 Doha, Qatar |
| **SPECIAL PUBLICATIONS** | | | | | |
| * Official Saudi Magazine<br>** Official Magazine | * Media Partner<br>** Official Technical Magazine | * Official Technical Magazine | | * Saudi Aramco Supplement | * Media Partner |

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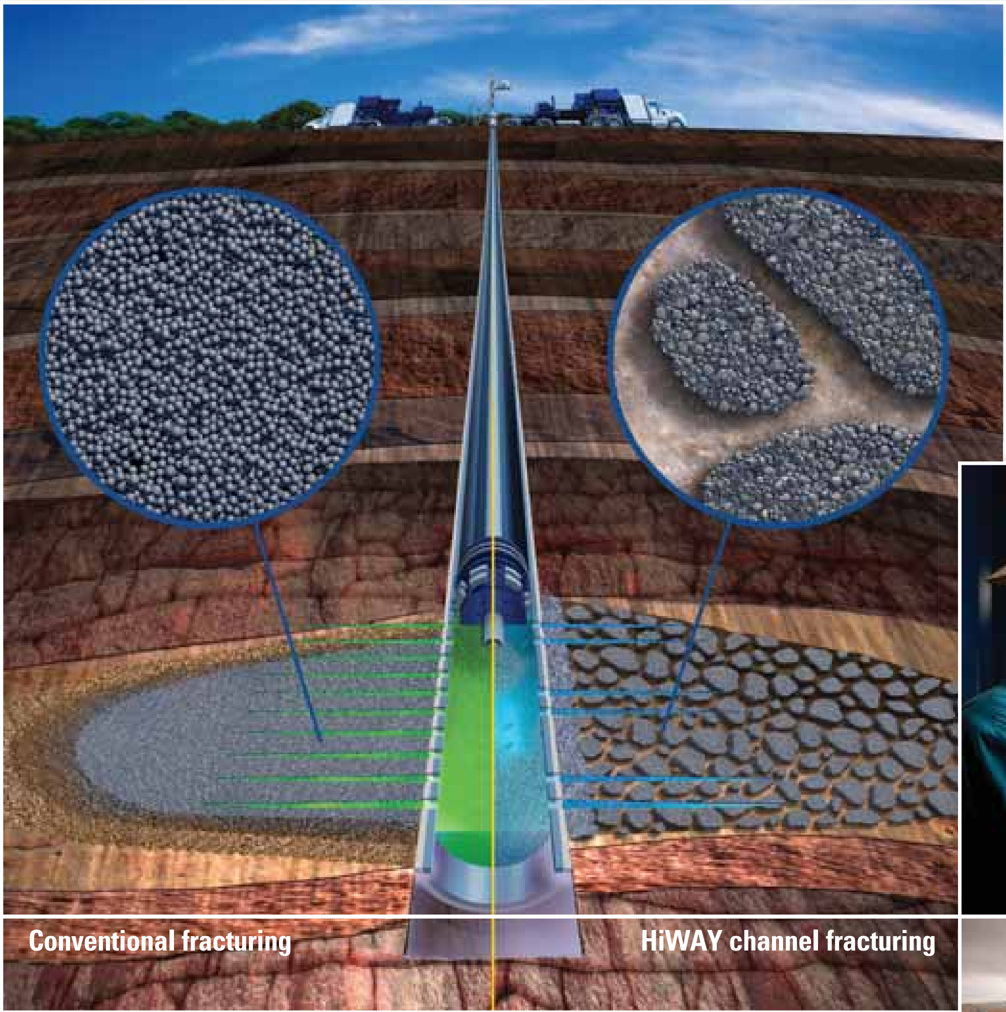


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