May 2014

The First

SPE Oslo magazine

ENERGY360º; CHALLENGES & OPPORTUNITIES

by Helge Hove Haldorsen p.,6

In this issue..

Electronic version http://oslo.spe.org/home/RESOURSES/Magazine

Photo: Daria Krasova, Geophysicist, Aker Geo

Full day seminar

Oslo Section
Society of Petroleum Engineers
Oslo Section

Annual Workshop

Financing E&P Companies and Projects

4 June 2014 | PwC AS, Dronning Eufemias gate 8, 0191 Oslo, Norway

Technical program

Welcome and Introduction

Changes in the regulatory environment

Reserves based lending

IPO/Equity financing: Case study

Bond market financing in E&P Companies
Transactions in the License market: License Portfolio, APA

Financial considerations: How to avoid financial failure in E&P companies

Upstream project value, Farm-in, Farm-out, data room

Company's future strategies: Company acquisitions, field development projects, IOR/EOR, seismic

Oil price outlook and costs in NCS: activity-driven vs. price-driven

Panel discussion:
What is the outlook for the Norwegian oil and gas industry?
- Oil price outlook
- Investment outlook in NCS

Committee Members

Marius Lunde, Idemitsu Petroleum Norge

Jafar Fathi, CORE Energy AS

Per Fossan-Waage, PwC Norge

Per Gunnar Ølstad, Oslo Børs

Karl Ludvig Heskestad, Resoptima

Event Sponsors

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OSLO BØRS

Reception at Oslo Børs

For more information and registration please visit: http://oslo.spe.org/home
http://www.pwc.no or http://www.oslobors.no

SPE Oslo Annual Seminar – sponsored and hosted by PwC and Oslo Børs – will this year focus on the financing of E & P companies and projects on the Norwegian Continental Shelf. After an introduction on regulatory changes in the oil sector, the various sources of financing available for the oil companies and projects are covered: From reserve based lending, to equity and bond financing. Lunch is then served at the top of the PwC building, with a grand view over downtown Oslo. After lunch the Norwegian market for license transactions is presented, as divesting licenses is also a way to secure financing of other projects. Securing financing is one thing, but still another issue is why E & P companies still end up in financial troubles. Lessons from the past are presented. As oil reserves are crucial for financing of the oil companies, the seminar continues on how to grow the oil reserves; with specific cases on tail end production and enhanced oil recovery. This session covers the key decisions that top management need to address at important milestones of project development. As a prelude to the panel debate, Rystad Energy will present facts on the cost explosion in the Norwegian oil industry. The panel is made up of representatives from both the oil service sector and the oil companies, as well as analysts that have followed the sector over many years. After the seminar a reception is held at Oslo Børs, where the Exchange meets with the seminar participants.

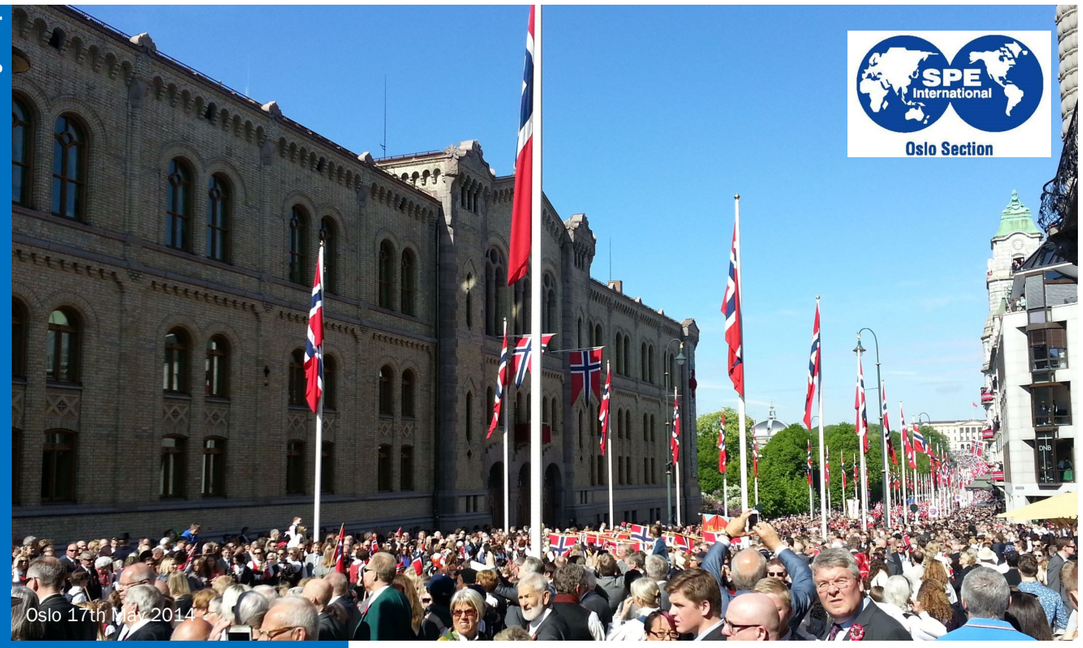
Time: June 4th, seminar starts 08:30 after registration and coffee
Place: PwC, Dronning Eufemia Street 8, reception at Oslo Børs
Attendance fee: NOK 1,500
Registration (påmelding): pwc registration
The event is in English

Financing E&P Companies and Projects on NCS

4 June 2014 - PwC building – Reception Oslo Børs

08:00 – 08:30	**Registration & Coffee**
08:30 – 08:45	**Welcome and Introduction** by SPE Oslo
08:45 – 09:00	**The regulatory environment** PwC, partner Gunnar Slettebø *Regulatory changes in the E & P sector that the companies should be aware of*
09:00 – 09:30	**Reserves based lending** Head of Reservoir Engineering Nicolas Decaillet, BnP Paribas *Considerations to be made when achieving bank financing based on your oil reserves*
09:30 – 10:00	**IPO and equity financing: Case study** Atlantic Petroleum, CEO Ben Arabo *Lessons drawn from raising equity financing*
10:00 – 10:15	*Break*
10:15 – 10:45	**How does the E&P sector, on and off the NCS, utilize the Norwegian bond market?** Oslo Børs, Senior Listing Manager Per Gunnar Ølstad *Analysis and cases presented*
10:45 – 11:15	**Company's future strategies: Company acquisitions & strategic decision making on field development projects** Professor Reidar Bratvold, University of Stavanger, Norway *Considerations to be made when growing the oil reserves through increased/enhanced oil recovery*
11:30 – 12:30	Lunch
12:30 – 13:00	**Transactions in the License market** Kluge Legal firm, partners Olav Hasaas & Audun Sto *Issues to be considered when selling (or buying) existing licenses – with cases*
13:00 – 13:30	**Upstream project values, Farm-in, Farm-out, data room** IPRES, Managing Director Arvid Elvsborg
13:30 – 13:45	*Break*
13:45 – 14:15	**Financial considerations: How to avoid financial failure** Swedbank, Teodor Sveen Nilsen *Many E&P companies end up in financial troubles. What are the lessons to be learned?*
14:15 – 14:45	**Oil price outlook and costs in NCS: Activity driven versus price-driven** Rystad Energy *An analysis of the costs of E & P activities on the Norwegian Continental Shelf*
14:45 – 15:00	*Break*
Panel discussion **15:00 – 16:00**	**Panel discussion: What is the outlook for the Norwegian oil and gas industry?** • Rystad Energy (Managing Partner Jarand Rystad) • ABG Sundal Collier (analyst John Olaisen) • PwC (Partner Henrik Zetlitz Nessler) • Statoil (VP Arild Dybvig, Strategy and Business Development) • FMC Technologies (Terje Skogen, Regional sales manager NCS & Denmark) **Moderator**: Teodor Sveen Nilsen (Analyst, Swedbank)
16:00-16:15	*Break*
Reception 16:15-19:00	Reception and networking at Oslo Børs. Light refreshments.

Issue 2
May 2014



Inside this issue:

Dear SPE member,
you are reading the second edition of SPE Oslo Magazine "The First". On behalf of the SPE Oslo section board I would like to say thank you very much for your feedback and inputs on the first edition of "The First"!

Vita Kalashnikova
Editor of "The First"/
SPE Oslo YP Chair /
Reservoir Geophysicist
PSS-GEO AS

In this magazine we will again invite you to several of our upcoming events, report from recent activities in the SPE Oslo region and the other Norwegian sections and share glimpses from the activities in the YP and student chapters. In this 2nd edition I'm very proud to announce that you are the First who is going to know more about a revolutionary technology for reservoir modelling which has just been implemented in Norway. And we will also let you be inspired by our local engineering design and environmental EOR studies which will help cover global needs. We will give you first-hand information about global energy demand and supply outlook - the SPE president 2015 Helge Hove Haldorsen has shared with us his vision, and also you will learn about assessment and delineation of Arctic resources from Vice President of the World Petroleum Council, Professor Anatoly Zolotukhin.

Enjoy your reading and do not hesitate to send us feedback or ideas for later editions. **See you at *SPE Oslo Seminar: Financing E&P Companies and Project, 4th June*!**

The SPE Oslo Board Election 2014-2015 Season!

Open positions:

Chairman, Program Chair, Student Liaison Chair and Director.

If you are interested in becoming part of the board, please contact the election committee:

Kristine Behné Ramsnes
ramsnes@gmail.com

Jafar Fathi
jf.fathi@gmail.com

Dear SPE Member,

The First is a free magazine available for everyone to download from the SPE Oslo web site.

If you would like to receive a hard copy of *magazine*, please send your request with post address to:

vita@pss-geo.com

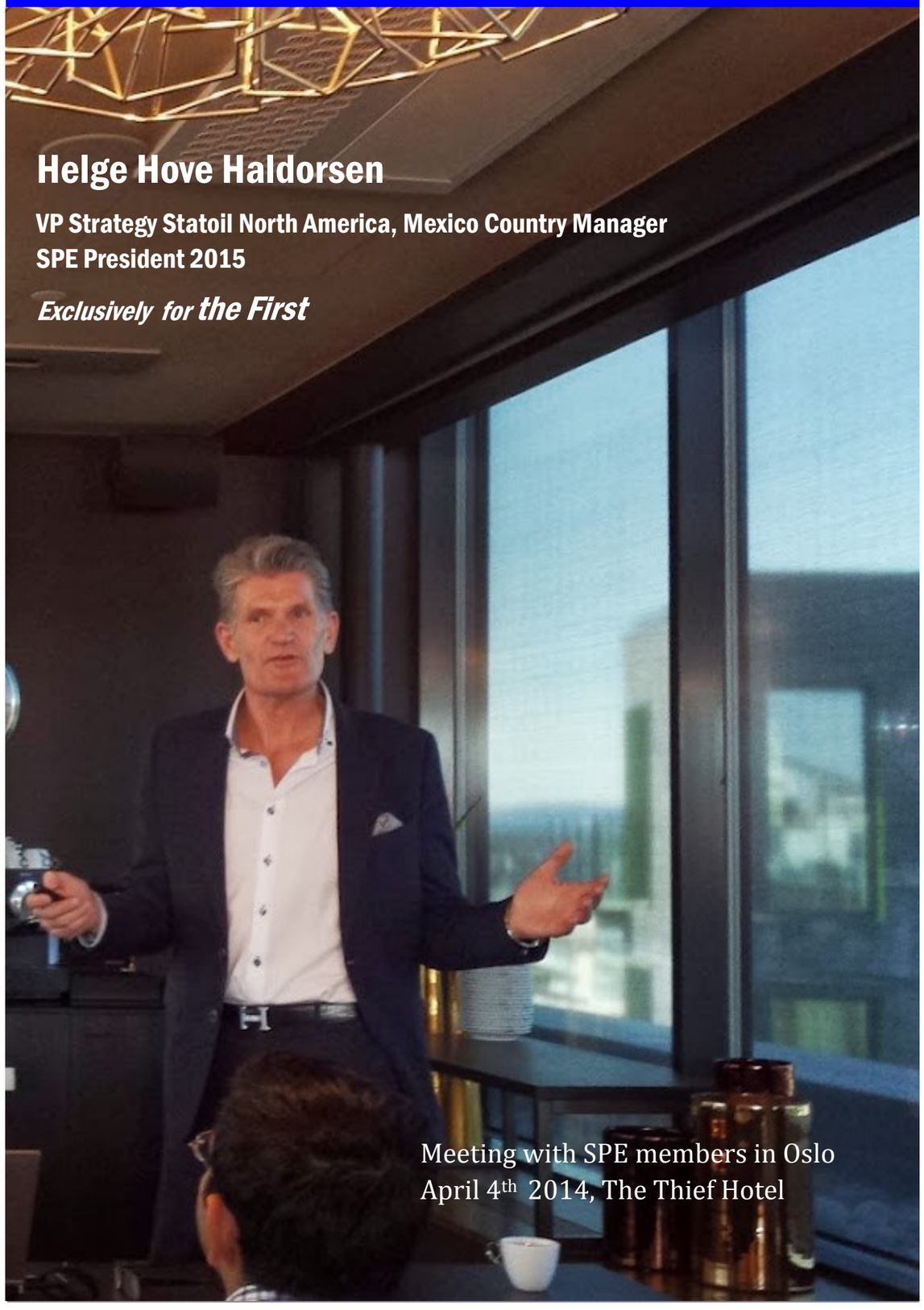
patent trademark design
Norwegian Industrial Property Office

Thursday
June 5 2014
11:30 AM - 1:00 PM

Lunch Meeting -
Norwegian Industrial Property Office

The Intellectual Property Rights Advisory Board invites SPE Oslo members to a lunch meeting to present and educate SPE Oslo's member companies on usage and protection of Intellectual Property Rights.

Patentstyret, Sandakerveien 64 ,Oslo 0484



ENERGY360º; CHALLENGES & OPPORTUNITIES

by Helge Hove Haldorsen, VP Strategy Statoil North America, Mexico Country Manager, SPE President 2015

In his presentation, Helge discussed the global energy demand and supply outlook and the critical roles of I+4E. By 2035, the International Energy Agency has documented a need to develop new capacity equivalent to 40 million barrels of oil in daily production and ExxonMobil, Shell and BP in their 2014 energy outlooks, agree that oil and gas are still global energy supply 'kings' in 2040! So we have the work cut out for us.

The 'recipe for success' in this enormous energy undertaking is: **I+4E. I** is for Imagination; With people asking Why?, What if? and How? mankind invented fire, the wheel and flint arrow-heads, the most high-tech tools anywhere around 15,000 BC. Fast forward to 1969 when Armstrong stepped onto the moon – it's just amazing what mankind can do. Today, we routinely develop fields in 10,000 ft. of water, which is like going to the moon every day. In business, 'success is never final' because imagination followed by innovation or 'creative destruction' are behind new technological developments – radical and incremental – that never stop. There will always be a 'next big thing' – so there will always be a 'next old thing'. This relentless pushing of the technology envelope gives mankind the ability to improve, renew and adapt. The 'winners' are either picked by the 'invisible hand' (the market place) or increasingly, by governments via mandates, incentives, regulations and laws.

'The state of E&P' in 2014 with low margins and inadequate returns according to activist investors and the need to refocus attention on value rather than on volume. So we must continue to 'creatively destruct' (=relentlessly improve) every aspect of the E&P business (the E&P business models, the E&P companies, the various HC supply candidates and you and me) to 'stay fit' in the new normal as all the 'easy and cheap' oil has been produced. According to Prof Scott Tinker at UT Austin, the energy supply winner will be the energy supply that wins in 4E (rather than in 3D). The 4 Es stand for **E**nergy (supply and demand – we must supply sufficient amounts for the demand arising from 9 billion people in 2040 (7.2 billion now), **E**conomics (the energy must be affordable for all and we need to get electricity to the 1.3 billion people who now are without it), **E**nvironment (the energy supply must be sustainable) and the pillar of all the energy Es: **E**ducation!

I was quite impressed with 'NCS version 2.0'; It is still a world class E&P theatre of operations with impressive recovery factors (>50%), with new technology being piloted and implemented (e.g., subsea compression etc.), with more offshore multilateral and 'smart' wells than in the rest of the offshore world combined (e.g., Troll oil etc.) and with new amazing billion-barrel discoveries due to 'new G&G ideas in old places' (Johan Sverdrup etc.). On the NCS, the E&P community really continues to say Why Not?, What If? and How? and he was very impressed by the answers!

Energy fuels human progress and rises living standards. Technology makes energy happen and STEM (science, technology, engineering and math) makes technology happen.

And, in the end, I would like to say about the right of petroleum engineers to feel a great sense of purpose. SPE members belong to an organization with 'a mission to share'. And, in the process of sharing, SPE and its members become the 'rising tide that lifts 125,000 boats' around the world when it comes to petroleum engineering best practice. Every day in 2014, SPE members help produce ~90 million barrels of oil and ~350 billion cubic feet of gas – an enormous achievement which gives every one of us the right to feel a great sense of purpose! 'We're not just cutting rocks, we're building something great' for 7.2 billion people every single day.

ARCTIC – ANOTHER PERSIAN GULF?

by Prof. Anatoly Zolotukhin,
Research Director, Institute of Arctic Petroleum Technologies
Gubkin Russian State University of Oil and Gas

Prof. Anatoly Zolotukhin
Counsellor, International affairs / Research Director, Institute of Arctic Petroleum Technology Gubkin Russian State University of Oil and Gas / Vice President of the World Petroleum Council

The Arctic continental shelf is believed to be the area with the highest unexplored potential for oil and gas. Despite a common view that the Arctic has plentiful of hydrocarbon resources there are ongoing debates regarding the potential of this region as a future energy supply base. Driving forces for such discussions are geopolitics, environmental concern, assessment and delineation of Arctic resources, technology available for their successful development and, not the least, the market demand for energy supply.

It is not only petroleum resources of the Arctic that are poorly explored. Our general knowledge of global ecosystems and the overall impact on them made by human activities is scarcely studied. There is very little knowledge on how offshore oil and gas resource development will impact climate change in a long-term perspective. This is especially important for the vulnerable Arctic areas and northern seas. To secure safe and efficient development of arctic resources new regulations and environmental standards should be jointly developed by the international community.

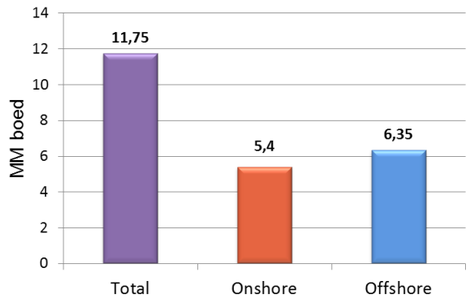
Another issues like *logistics* and *human factor* that greatly affect efficiency of the arctic operations should be further studied. Mobilization cost, time required to transit and custom clearance are among main logistical issues that should be addressed to improve effectiveness of operations in the Arctic. Special priority should be given to selection of qualified personnel, cold climate training procedures and equipment to avoid/reduce human mistakes in the Arctic.

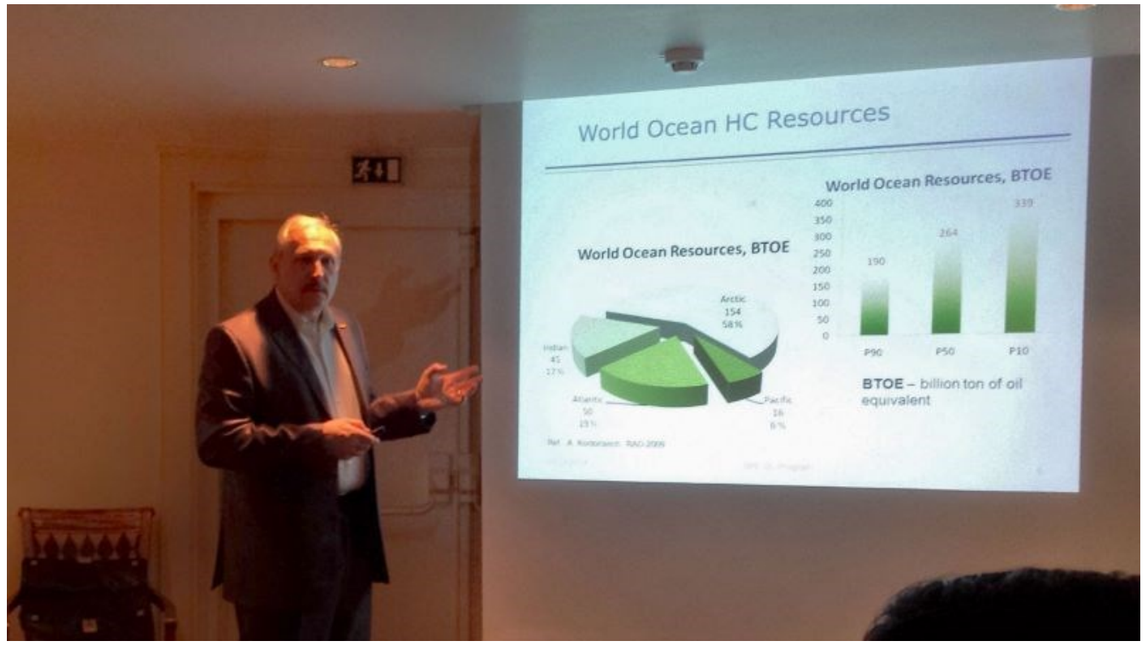
Internationalization of education is another important aspect. Collaboration of universities can greatly contribute to the Arctic development. International graduate and postgraduate programs as well as collaborative research projects can facilitate cross-border knowledge transfer and foster technology development. This thesis is well illustrated by a ***Russian-Norwegian joint master double degree program*** entitled "Offshore Field Development Technology" established by Gubkin Russian State University of Oil and Gas and Stavanger University in 2010. Today 16 graduates with excellent knowledge of math, physics and technology are already working in the best oil major and service companies worldwide. Another result of this collaboration – several textbooks and monographs together with dozens of papers has been published, two international patents have been granted.

Do we have an alternative to the development of oil and gas fields located in the Arctic offshore areas? The development of Arctic resources is inevitable although there should be no hurry in doing that. Development of he Arctic should go through necessary stages in sustainable way step by step overcoming new challenges and strengthening our knowledge and competence.

There is no doubt that in the second part of XXI century production of HC in the Arctic petroleum mega basin will be as important in energy supply as Persian Gulf and West Siberia basins today. Our estimates show that by 2040 the arctic conventional oil and gas resources will contribute with 5.5 billion boe of annual production, which is 4.2% share of the global supply of primary energy resources and nearly 8.2% of anticipated world oil and gas production. Taking into account that the Arctic is still underexplored its actual potential could be even higher.

Production potential of the Russian Arctic





Distinguished lectured dinner at Hotel Continental, April 8 2014

Novel technologies for fine scale dynamic modeling in Lundin Norway

by Dmitry Eydinov (Rock Flow Dynamics)

Dmitry Eydinov
Business Development Director
Rock Flow Dynamics

Lundin Norway AS is the most rapidly growing operating company in Norway. With recent discoveries in the North Sea it currently holds the position of the second largest oil company in the country.

Reservoir engineers in Lundin implement multiple innovations in order to optimize development of the fields operated by the company. One of the current projects is to investigate opportunities to enhance oil recovery from the Johan Sverdrup field by polymer injections. It is believed that this option will help improve the reservoir performance significantly.

One of the most important and challenging parts of the project is related to numerical modeling. An accurate description of the polymer flooding effects requires high-resolution dynamic models. Reservoir engineers often adopt sector models for such studies to make the simulation time more feasible. However, in this case this approach cannot be applied directly as the common network facilities have to be taken into account. So, a dynamic model of the giant field with high grid resolution is considered for the study. Combined with polymer modeling options, it makes the simulation time very challenging. As the field is at the early development stage and the information is very limited, a thorough uncertainty study with hundreds of simulations is required to draw reliable conclusions of the polymer flooding effects.

Preliminary tests of the dynamic model revealed that the simulation time required for one run is far too long for a detailed study with conventional simulators. That is why Lundin decided to try tNavigator® developed by Rock Flow Dynamics, which is quickly being recognized around the world for its simulation performance.

Rock Flow Dynamics started as an independent software vendor in 2005. tNavigator® is the flagship product developed by the company. This is a full-fledged black oil and compositional reservoir simulator implemented from the beginning to run parallel. The key feature of the simulator is the scalable solver which is optimized for modern multi-core computers. Recent studies of parallel computation methods implemented in tNavigator® show that the model simulation time can be reduced almost boundlessly as the number of simulation cores grows. The parallel hybrid algorithm mixing MPI and system threads was applied to a number of real models and demonstrated a record parallel acceleration.

The simulation performance tests on the model of Johan Sverdrup field show that **the total run time can be reduced from 9 hours to 45 min** even on a regular workstation. That will significantly reduce the length of the project and make a detailed uncertainty study realistic.

The project team would be happy to present the results to the SPE Oslo section when the work is complete.

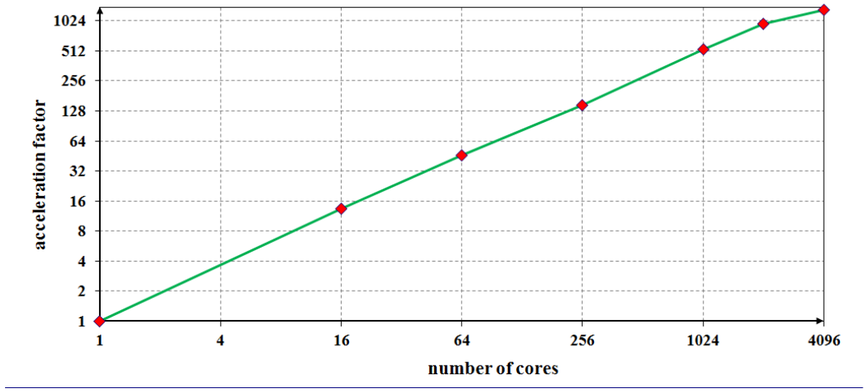


Fig.1. Speed-up for a 21.8 million active grid block model on a cluster (with respect to one core calculation time) (SPE 163090)

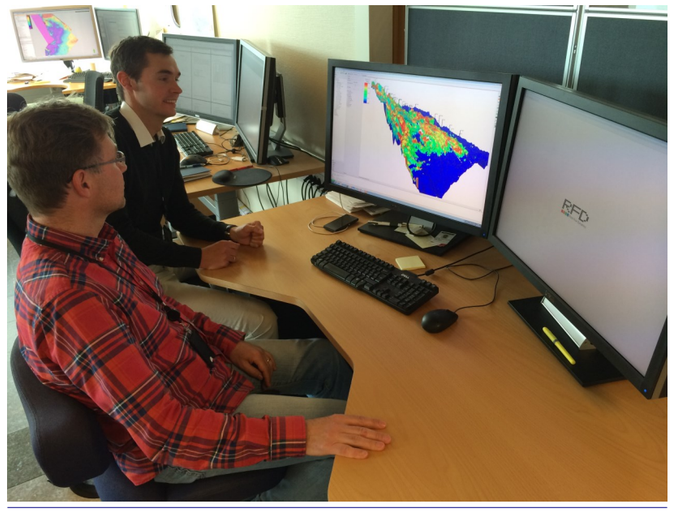
INTERVIEW WITH LUNDIN NORWAY

Jens-Petter Nørgård & Geir–Magnus Sæternes

-As operator of the PL501 license, where we made the Avaldsnes discovery, we of course have high focus on the Johan Sverdrup field. Polymer was early identified as a potential EOR method by the partnership of Johan Sverdrup. Lundin therefore initiated a research project with TIORCO (Houston) to identify the best suitable polymer for this reservoir and describe its characteristics to be used in dynamic simulation. In this regard the need for a faster simulator in order to evaluate polymer injection became obvious. At this time we were given a presentation of tNavigator. The speed and ease of use was really impressive! The only drawback was the lack of support for polymer injection, Jens-Petter Nørgård explains. *-However, we liked the product and saw the potential for our project so we suggested doing a project with RFD to develop polymer functionality and with the same simulation speed. RFD was positive to the idea so we initiated a project.*

Lundin specified the functionality requirements and RDF was left with the challenge to implement accurate polymer simulation at the same impressive simulation speed. A couple of months later RFD came back with a beta version for the Lundin engineers to test. The time was come to test and see if they had succeeded the challenge...

-The polymer functionality worked fine and the speed was amazing. We reported a few minor bugs that RFD fixed immediately, Geir–Magnus Sæternes says. *–I've used the tNavigator for a while now for our polymer study, but also other simulations since it's so fast and it fits nicely into our Petrel workflow. It's so intuitive that none of us had to attend any training course.*



Geir Magnus Sæternes and Paul Tijink on the photo using tNavigator

-Well, we do have extremely bright engineers too, Jens-Petter Nørgård says with a smile. *-However, we simulated all our polymer cases within the project deadline and tNavigator was an important tool,* he continues. *–Both simulation speed and the fact that our engineers could start using it without any training saved us a lot of time.*

Microbial Enhanced Oil Recovery (MEOR): Experiments and Simulation

by Jafar Fathi, Reservoir Engineer: EOR Studies, PhD, CORE Energy AS, Oslo, Norway

Dinner meeting at Continental, May 13 2014

Jafar Fathi
PhD
Reservoir Engineer
CORE Energy AS

Extensive laboratory research and field trials have been performed to evaluate the potential of microbial enhanced oil recovery (MEOR) in mature fields. In this work, the author tries to study the potential of injecting nutrient in a mature field in the Norwegian Continental Shelf (NCS) to improve the oil recovery by stimulating the growth of indigenous microorganisms. The technology of the focus does not require live microorganisms to be injected; instead, it depends on the resident microbes in the reservoir. With a specifically formulated nutrient solution, the resident microbes are stimulated to grow and to reproduce. The nutrient formulation plays a key role, and it must contain a carbon source and other elements required for the bacterial growth such as nitrogen and phosphorous. Furthermore; the success of the process depends on the microbes, which are present in the reservoir. The injected water is the transport medium of the nutrient and it distributes the nutrient throughout the reservoir.

Several mechanisms have been proposed in the literature attributed to the enhancement of oil recovery by microbial interaction. In this study, we focus on the MEOR mechanisms of interfacial tension reduction and wettability modification via bio-surfactant, and selective plugging via bio-film. The effect of MEOR is simulated in Eclipse by a combination of SURFACTANT and POLYMER options to predict, estimate, and to monitor the process during the field trial. The field is a mature field, which is producing at about 95% water cut. The main drainage strategy of the field is water flooding; the implementation of MEOR does not need major modifications, and the investment is low. The reservoir is a complex and heterogeneous reservoir with an estimated ultimate oil recovery of about 35%. Therefore; there is a huge potential for the application of enhanced oil recovery processes.

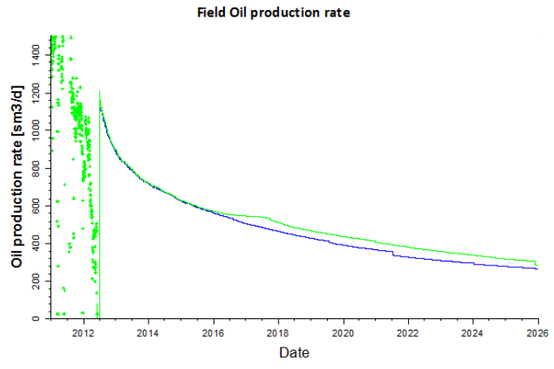


Figure 1 Field oil production rate (nutrient treatment for two years)

In the field case study, the nutrient is injected in two water injectors at 500 ppm concentration for two years. The response is studied in four producers, which are supported by the injectors. The simulation results indicate that the nutrient injection has a potential to recover 1-5% of the remaining oil. Injecting nutrient can achieve about 160000 Sm^3 of incremental oil after 10 years (Jan. 2026), **Figure 1 & 2**. Also, water cut is reduced by about 1% due to the formation of bio-film and permeability reduction in the high permeable zones, **Figure 3**. The estimated response time is about 2-6 months in the producers; depending on the distance and communication between the producers and injectors. The process is identified as a potential technique to target the remaining oil in the reservoir. The results can be used to predict and to monitor the application of the MEOR technology during the field trial.

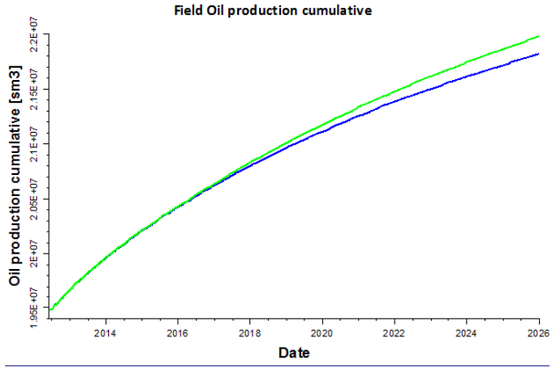


Figure 2 Cumulative oil production after 10 years

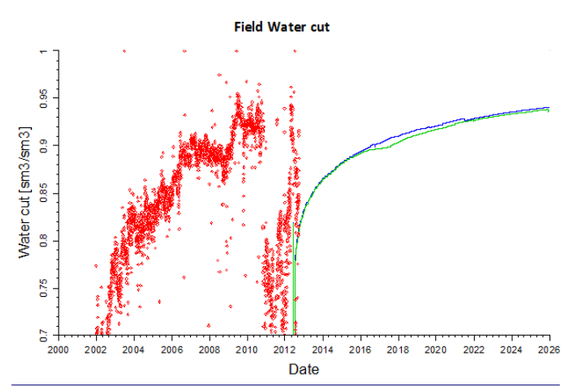


Figure 3 Reduction in the water cut due to formation of bio-film in high permeable channels

Lectured dinner at Hotel Continental, April 13 2014

Understanding the Impact of Chemicals in Produced Water in Enhanced Oil Recovery (EOR) Projects

by Michael Nilan[1], Pascale Stang[1], Mona E.Dadkhah[1,2] , Ashish K Sahu[1]

1. Aquateam COWI AS, Hasleveien 10, N-0571, Oslo, Norway (www.aquateam.no), 2: NTNU, the Ugelstad lab.

Michael S Nilan, *MSc. Environmental Technology, Consultant*

Pascale Stang, *MSc. Ecotoxicology, Consultant*

Mona Eftekhardadkhah *Researcher, Department of Chemical Engineering,*

Ashish K Sahu.*, PhD Environmental Engineering, Process Engineer and*

Enhanced oil recovery (EOR) is a generic term used for increasing the amounts of crude oil that can be extracted from an oil reservoir or an oilfield. Usually this is done in an effort to increase the output of a matured field where conventional-recovery methods have been exhausted. EOR efforts require strong reservoir characterization techniques i.e. fractured network mapping, permeability distribution through well tests, and permeability upscaling.

Methods used for EOR

Four prevalent methods for EOR are (Bai, 2011):

- Gas injection is the most technically feasible EOR operation at low permeabilities, and is the most widely applied method for light-oil recovery. Methods include, gas flooding, gas injection, use of miscible gases, nitrogen injection, carbon dioxide gas injection and CO_2 flooding.

- Thermal processes are best suited for heavy-oil reservoirs that cannot be produced efficiently from cold flow. Within this steam injection and solar thermal methods are adopted.

- Microbial Enhanced Oil Recovery (MEOR) is a biological based EOR technology where three general strategies exist for the implementation of MEOR: (1) Injection of nutrients to stimulate indigenous microorganisms, (2) Injection of exogenous microorganisms(s) and nutrients, or (3) Injection of ex situ produced products, e.g. biosurfactants. This is the simplest, and most likely for short term success in full field-scale.

- Chemical processes are used for oils that are more viscous than those recovered by gas injection and less viscous than those involving thermal processes. Polymer, alkaline/surfactant/polymer (ASP) and surfactant flooding are included in chemical EOR operations (CEOR).

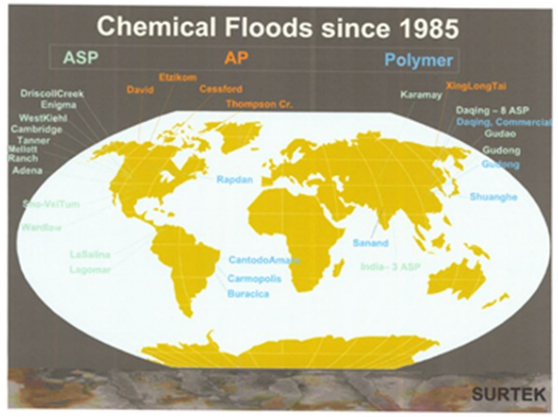


Figure 1. Chemical floods, which according to Surtek (2014) have been implemented since 1985

The application of chemical enhanced oil recovery (CEOR) floods are increasing, see Figure 1. All fields are onshore. Angola operated by TOTAL (Morel et al, 2008) and one or two fields in China have also been initiated for chemical flooding. The use of chemicals is considered most effective; moreover, the use of polymer is one of the most cost-effective methods, based on bench-scale (lab testing) as well as field (Bai, 2012) investigations. For this reason, there has been increasing interest in the use of polymer and hydrolyzed polyacrylamide (HPAM) polymer in particular. Chemical flooding with polymers alone or in combination with surfactants are planned in many new fields also offshore.

Environmental properties of most relevant chemicals

Polymer and EOR-surfactants chemical properties challenge the classical risk assessment methods developed for production chemical. First step in risk assessment is HOCNF testing (Harmonised Offshore Notification Format according to requirement from OSPAR 2014). Those ecotoxicological tests are used to classify the chemical in one of the four color categories (Figure 2):

- Not environmental acceptable: Black chemicals are generally not allowed discharged.

- Replacement should be considered: Red chemicals require special approval before use, because they have either a low biodegradation potential, a relatively low biodegradability in combination with high bioaccumulation potential and or notable toxicity.

- Acceptable: Yellow chemicals have no inherent environmentally hazardous properties

- Acceptable: Green chemicals are listed under PLONOR “Pose Little Or NO Risk “ (OSPAR 2012)

EOR chemicals may, however, be biodegraded under environmental conditions given longer time and more inoculum than in the ready biodegradation tests. Anaerobic biodegradation can also occur in the sediments, and since many of these chemicals are likely to adsorb to solids present in the produced water and in the sea, they might very well end in the sediments. Onshore they will usually be eliminated in biological wastewater treatment even if they are not ready biodegradable. However, biological treatment processes are not considered a process which can be implemented offshore. The long retention time needed for the water to be treated in biological processes, results in a footprint and weight which is not available.

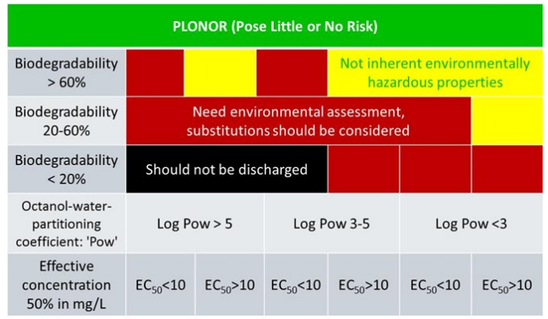


Figure 2. Color-coded classification for chemicals according to Norwegian and OSPAR regulations. More Complex chemicals are less biodegradable

Topside produced water management issues

Very high concentrations of polymer and surfactants are likely to be found in the back produced water. Typical examples reported from Chinese onshore fields are polymer concentrations in the range of 500 mg/l and surfactant concentrations could be even higher; ~10000 mg/l. It is therefore expected that future regulations could require produced water re-injection (PWRI) with high uptime (80-95 %) of the plant, and that treatment of produced water could be needed in the residual time period before produced water is allowed discharged overboard.

On top of toxicity and environmental issues caused by EOR chemicals, their back production can influence the whole production chain including performance of oil/water/gas separators and the following produced water treatment processes. Problems caused by polymers are expected to be mainly related to an increase in viscosity of the water phase. Moreover, high concentration of back produced polymers can stabilize the oil in water emulsions and cause separation difficulties in many water treatment facilities such as flotation units and hydrocyclones. Polymers are large molecules and they can prevent coalescence of oil droplets as they adsorb at oil droplet interfaces (steric stabilization). Figure 3 shows how polymers influence the coalescence of oil droplets as their concentration increases (Wang et al 2011). It is known that an optimum formulation of EOR surfactants is normally injected to obtain maximum oil recovery. This optimum formulation corresponds to minimum emulsion stability and is anticipated to not to cause any further separation difficulties. However, the back produced fluids

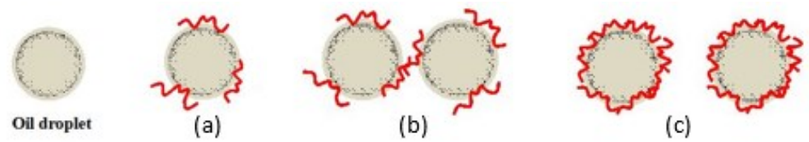


Figure 3. Influence of polymer adsorption on coalescence of oil droplets (a) polymer adsorption at oil droplet surfaces, (b) droplets may flocculate at low polymer concentration, (c) droplets remains apart (very stable emulsions) at high polymer concentration

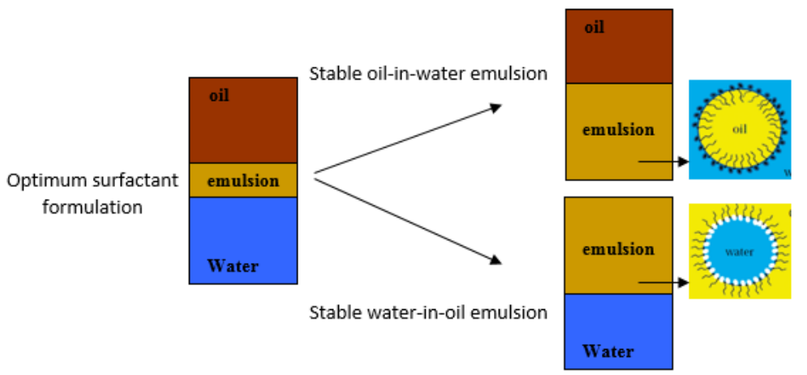


Figure 4. Back produced fluids can easily be shifted from optimum EOR surfactant formulation and both oil-in-water and water-in-oil emulsions may formed

are shifted from the optimum due to many reasons including adsorption of surfactants inside the reservoir, chromatographic effect between the different chemicals injected, salinity gradients, temperature differences and etc (See figure 4). Therefore, stable oil-in-water and water-in-oil emulsions are the main problems caused by EOR surfactants and has been a focus of so many studies during the last years (Argillier et al., 2013 and 2014, Yee et al., 2013, Najamudin et al., 2014).

Furthermore, adsorption of surfactants on gas bubble interfaces can cause foaming problems. Foams take up space in the separation facilities including separators and flotation units and reduce the separation efficiency. Foams can also interrupt the pumping of the fluids at transfer stations and increase the energy consumption of topside processes (Wang et al 2013).

Both polymers and surfactants can influence the performance of filtration facilities and can cause fouling or deformation of droplets in the way that they can pass through the filters and reduce the efficiency of filtration units.

Considering tall these several unique challenges related to separation and produced water treatment as a result of application of EOR chemicals into the oil fields, proper testing is needed in multiple disciplines including separation processes, environmental science and new chemical development to find solutions for encountered difficulties.

Figure 5. Toxicity testing of whole effluent (here with Skeletonema: marine algae) gives valuable information of environmental risk

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Environmental impact testing

Chemical qualification requires HOCNF information (Harmonised Offshore Notification Format). Detailed requirement are available through OSPAR (2013). OSPAR (2012) has also prepared Guidelines for Risk Based Approach (RBA) to the management of produced water discharges. Whole effluent assessment of treated produced water is a good approach to control if EOR chemicals back produced to the platform has increased the toxicity of produced water.

Produced water treatment testing

In any offshore project who are planning to implement CEOR, environmental impact assessment and produced water treatment testing is likely to be needed. Once a set of chemicals are decided, work needs to start. Normally you would start with desktop studies and literature review to get focused on the critical aspects for the particular project.

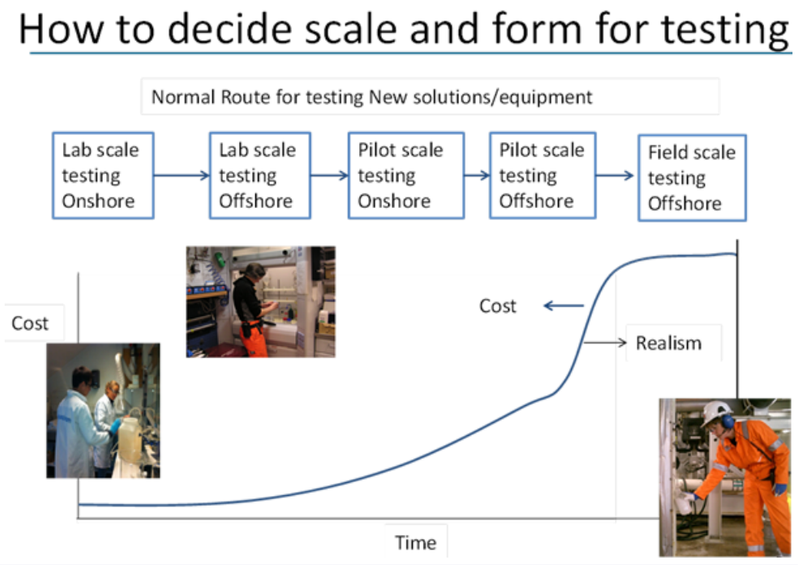

Figure 6. Steps identified for testing the fate of polymers and chemicals used in EOR

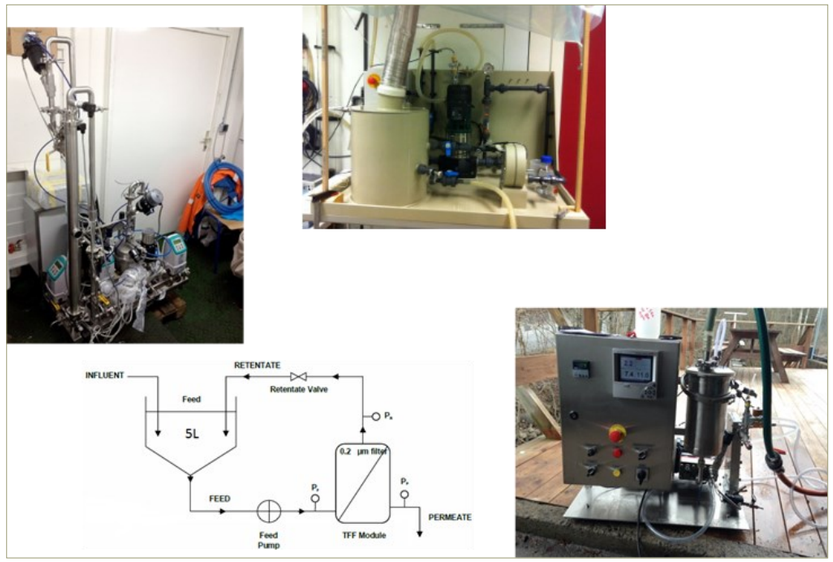

Figure 7. Test skids, including ceramic membranes (CM), Advanced Oxidation, ultrafiltration (UF) and nanofiltration (NF)

"Relevant testing" can mean applying the appropriate conditions that the chemical would experience (real produced water, right temperature and pressure), but also the appropriate scale.

Full-scale testing is the most relevant, but can be either extremely expensive or impossible to perform, or both. The closer one can come to emulating real conditions that the chemicals would experience, the more realistic and relevant the results will be; however, lab studies can be used as a precursor to pilot-scale and then the full-scale testing as suggested by Aquateam COWI (Figure 6). More realistic studies take more time and cost more. However, optimized test conditions can be found on the lab-scale and upgraded to a pilot to provide the information needed. For testing including performance in the separator, using the fresh oil (not exposed to air/oxygen) right pressure and temperature becomes critical.

Ideally, a balance should be struck between the efficacy of the chemical and how environmental friendly it is. Aquateam COWI has been in the vanguard of water treatment testing polymers and different chemicals and their fate in the environment as well as water characterization of produced water and effluent streams. Biodegradability studies of chemicals, including HPAM, have been performed in order to help clients determine the best form of chemical treatments. This helps the oil clients find effective chemicals that are properly treated to allow for a non-toxic effluent. A key part of determining the treatability and biodegradability of the chemicals present in produced water and effluent water streams is characterizing the produced water. Common analyses performed include the following:

- Particle size distribution (PSD) and oil droplet size distribution, gas bubbles distribution using Flow Cytometry, FlowCam, Malvern Mastersizer, nanosizer
- Particle charge by measuring the Zeta potential
- Biodegradation tests both aerobic and anaerobic over extended periods in sea water, fresh water and their sediments.
- Interfacial tension (IFT), viscosity, oil-in water, water-in oil etc. are other relevant parameters.

Additional treatment of produced water to meet discharge permits, could include a number of different approaches, but normally screening appropriate technologies needs to be done. This could include adsorption processes, oxidation, chemical treatment and by using emulsion breakers and flocculants. Figure 7 shows some test skids, applied by Aquateam COWI during such tests.

Due to the prevalent use of polymer and surfactants for EOR as well as the current environmentally conscious mindset surrounding the industry, it is important that treatment of EOR effluent streams and produced water be taken into consideration. Finding the best available technique (BAT) is likely to become a regulating parameter.

References

Argillier, J-F., Dalmazzone, D., Henaut, I., Mouazen, M., Noik, C., Boufarguine, M., (2013) Methodological approach for analyzing the impact of chemical EOR on surface processes. SPE 164098.

Argillier, J-F., Henaut, I., Noik, C., Viera, R., Roca Leon, F., Aanesen, B., (2014) Influence of Chemical EOR on Topside Produced Water Management. SPE 169067-MS.

Bai, B. (2011) EOR Performance and Modeling. Journal of Petroleum Technology, 63 (1): 42.

Bai, B. (2012) EOR Performance and Modeling. Journal of Petroleum Technology, 64(1):60.

EOR industry technologies. (2014) http://www.enhancedoilrecovery.com/

Morel, D., Vert, M., Jouenne, S. and Nahas, E. (2008) Polymer Injection in Deep Offshore Field: The Dalia Angola Case. Paper presented at the 2008 SPE Annual Technical Conference and Exhibition held in Denver, Colorado, USA, 21-24 September. SPE 116672.

Najamudin, K.E., Halim, N.H., Salleh, I.K., Ching Hsia, I.C., Yusof, M.Y., Sedaralit, M.F., (2014) Chemical EOR Produced Water Management at Malay Basin Field. OTC 24804-MS.

OSPAR (2013) OSPAR List of Substances Used and Discharged Offshore which Are Considered to Pose Little or No Risk to the Environment (PLONOR). OSPAR Agreement 2012-06 (Replacing Agreement 2004-10) Revised February 2013.

OSPAR (2012) Guidelines in support of Recommendation for a Risk-based Approach to the Management of Produced Watetr Discharges from Offshore Installations. OSPAR 12/22/1, Annex 19. Agreement 2012-07

Sheng, J. (2013): Enhanced oil recovery field studies, Chapter 12.

Surtek, (2014) http://www.surtek.com/

Vik, E.A., Shi, W., Bruskeland, A., Xin, G., Hennonge, L.B., Kjønnø, O. and Garshol, F.K. (2014) Environmental Impact of Discharges of Polymer Flooded Produced Water under different Produced Water Treatment Scenarios, Presentation at TEKNA's International 11th Produced Water Management Conference, Clarion Stavanger Hotel, 21-22 January 2014

Wang, B., Wu, T., Li, Y., Sun, D., Yang, M., Gao, Y., Lu, F., Li, X., (2011) The effects of oil displacement agents on the stability of water produced from ASP (alkaline/surfactant/polymer) flooding. Colloids and Surfaces A: Physicochem. Eng. Aspects 379, 21–126.

Wang, Z., Pang, R., Le, X., Peng, Z., Hu, Z., Wang, X., (2013) Survey on injection–production status and optimized surface process of ASP flooding in industrial pilot area. Journal of Petroleum Science and Engineering 111, 178–183.

Yee, H.V., Bt Halim, N.H., Bt Salleh, I.K., Bt. A. Hamid, P., B Sedaralit, M.F., (2013) Managing Chemical EOR (ASP) Effects on Formation Damage and Flow Assurance in Malay Basin, Malaysia. IPTC 16777.

Crude Oil Subsea Storage System

YP Dinner meeting at Olivia, April 23 2014

Torleif Torjussen
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Production and Integrity Solutions
Subsea Division
Kongsberg Oil & Gas Technologies

Kongsberg Oil & Gas Technologies is, through a Demo 2000 project, qualifying a Subsea Storage Unit (SSU) with support from Statoil, Lundin, Det Norske Oljeselskap and the Norwegian Research Council.

The SSU is characterized by using a flexible bag as oil / fluid storage. It's storage unit that differ from conventional gravity storage systems by use of a flexible bag, which eliminates contact between seawater and the stored fluid, thus eliminating the problems with emulsion layer and risk of bacteria growth. The bag is further covered by a protection structure, which accommodate the whole volume of the stored fluid thereby providing a second barrier should the bag rupture. There is free flow of seawater into the base of the protection structure and hence no needs to design against the water pressure. The top of the protection structure is designed such that the bag may be retracted separately from the storage tank if necessary for repair or replacement.

Different fields will have variable storage needs and the ability to size, combine and manifold multiple SSU's provides attractive flexibility. The number of SSU's can also be varied over the field life enabling subsea processing and production in arctic areas and also commercializing development of marginal oil field or tail end production.

The Subsea Storage System is intended for storage of stabilized crude oil at the seabed. The crude oil may be separated on the Topside platform or with Subsea processing and transported subsea through pipelines to the Subsea Storage Unit. The Subsea Storage Units will be discharged to a nearby shuttle tanker via a submerged offloading system or via topside.

The Subsea Storage Unit - is a subsea storage unit that utilizes a flexible bag for oil/liquid storage. The bag is further covered by a protection structure, which accommodate the whole volume of the stored fluid and thereby also providing a second barrier should the bag rupture. At the base of the structure there are openings providing free flow of seawater into the structure and hence no need to design against the water pressure. The top of the protection structure is designed with a special hatch arrangement enabling bag retrieval or installation separately from the protection structure if necessary for repair or replacement.

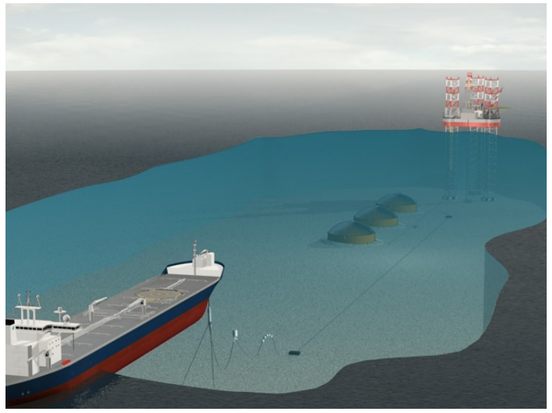


Figure 1 - Subsea Storage Unit configuration with topside processing

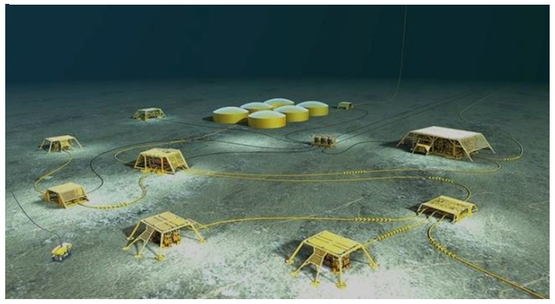


Figure 2 - Subsea Storage Unit configuration with subsea processing (Illustration courtesy of Statoil)

The base case configuration and size of the SSU chosen is 25,000m3 (~158,000 barrels).

Two types of materials have been recognized as feasible for the 25,000m3 protection structure; steel and concrete. Both these materials are used for building large offshore and subsea structures.

Both steel and concrete has Concrete gives good insulation, corrosion protection and sufficient weight to accommodate a stable installation. As an example, for a 25,000 m3 size SSU, a concrete construction will have a wet weight of approx. 8,000 tons. The buoyancy from oil in a full tank will, due to difference of density between oil and water, be around 5,000 tons. Concrete construction represents a structure based on field proven technologies and it can be fabricated locally in an existing dock or a special purpose graving dock can be established.

The protective structure is designed to keep all oil inside without any leakage to the environment in case of a bag failure or rupture and with water intakes dimensioned to match oil discharging rate with necessary safety margins

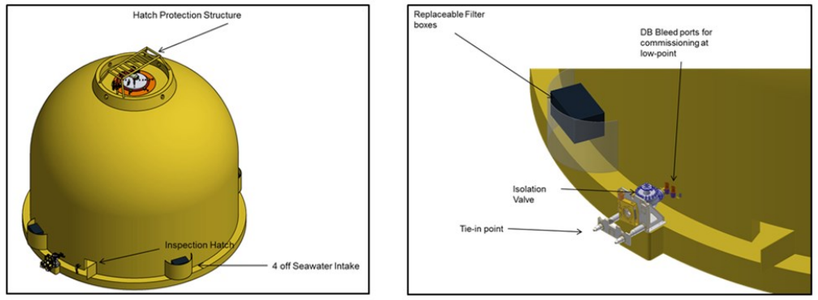


Figure 3 - SSU protection structure and tie-in point detail

Steel construction will be lighter than concrete. A steel construction for a 25,000 m3 size SSU will be in the range of 1-2000 tons wet weight and will hence be buoyant when filled with oil. To accommodate the positive buoyancy additional weights or pile anchoring is required for a stable seabed condition. Both corrosion protection and thermal insulation is required for the steel alternative. The amount of corrosion protection required is dependent on level of coating selected and may vary from application to application. Dependent on the characteristics of the specific crude oil additional insulation is required in order to meet requirements for wax temperature. Steel construction is based on proven technologies and can be fabricated in a dock or at an offshore yard. Choice of material will depend on customer preferences and soil properties for each specific installation.

Flexible bags for large subsea oil storage are a new concept but the use of flexible material exposed to oil, seawater, pressure and temperature is well known. Competent producers with proven production methods are available and have many years of experience. The main design criteria are the chemical resistance of the flexible bag material towards oil under influence of temperature and. Additional design criteria's are fatigue from bending and other wear and tear like friction between dome walls and bag.

Experienced producers are ready to produce the Flexible bag with the required quality and a life time of minimum 10 years.

Standard subsea crude oil storage systems are in general based on oil-water contact, where the reservoir is open to sea through a pipe system. The oil is replaced with water and vice-versa, when filling up or discharging from the reservoir.

One of the drawbacks with these storage systems is an ever growing emulsion layer comprising oil, seawater and chemicals. The chemicals are mainly added to the stored fluid in order to improve the separation of oil/seawater, reduce/avoid wax formation or reduce Microbiologically Induced Corrosion (MIC) caused by Sulfur Reducing Bacteria (SRB).

As the effect of the chemicals exhaust, more chemicals have to be added in order to keep the effect ongoing. Due to heavy restrictions regarding disposal of oily water or chemicals at sea, the emulsion layer becomes a problem. It is expensive to get rid of and takes up storage space in disfavour of the crude oil.

The emulsion layer also constitutes a risk of contaminating the discharged oil cargo. It only takes a relative small portion of the emulsion layer to raise the salt content of the crude oil cargo beyond acceptable specification, which will reduce its market price. Thus additional safety margins have to be added, which influence on the size of the layer and reduce available storage volume even more.

If not treated chemically, bacteriological growth occurs. Bacteria that 'consume' sulfur will form colonies that cling to the carbon steel walls and, during the 'digesting' process, produce acid which has a corrosive impact on the carbon steel.

There will also be a risk of transferring some of these bacteria to the shuttle tankers and further to the refineries, causing corrosion problems and clogged filters.

Eliminating the above mentioned threats by the SSU will enable the field-operators to secure their sale-spec. and fully optimize their storage requirement both volume- and cost wise.

The bag material is made of coated fabric with the core of wowen textile as the main load carrying structure, providing the required mechanical properties and strength. The coating on each side is designed to protect the textile and make it liquid proof. The total surface area of the bag is approximately 5 000 m2. The material is 1,5 – 2 mm thick and the total weight of the flexible bag is close to 10 tons.

Figure 4 - Rib boats, fuel tanks from Pennel & Filipo, membranes production from Continental

Figure 5 - Flexible bag design, production of bag, principle for vulcanizing sheets

Figure 4 illustrates different applications of this type of bag material.

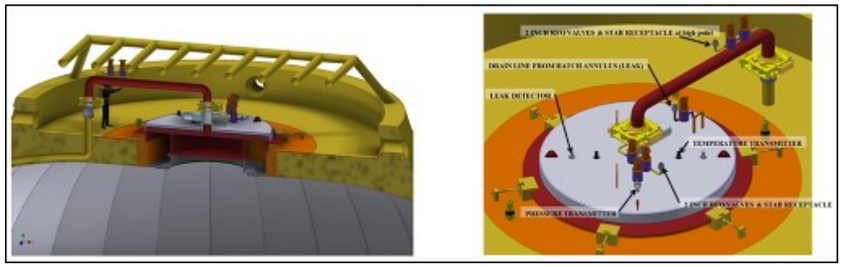


Figure 6 - SSU Hatch

Production of raw material and coated fabric are within normal production quantity and processes with good capacity. Joining or seeming the coated fabric sheets is a central part of the manufacturing. Each sheet will be cut to the right shape and slightly overlap the next sheet and the composition will form an overall approximate 3D surface and by the elasticity in the material it will easily fit to the perfect 3D shape in the dome.

Figure 5 illustrates the bag design and the production method for joining material sheets into final product.

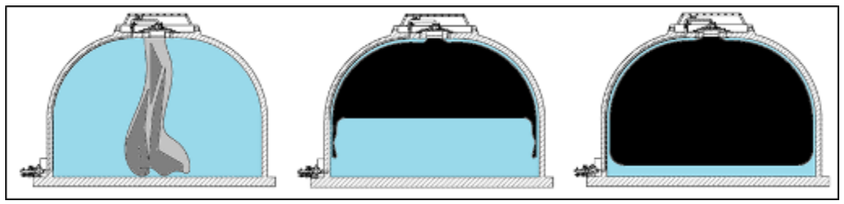


Figure 7 - Sequence for bag filling

The hatch arrangement on top of the protection is designed to provide full sealing and mechanical connection between the structure, bag and the environment. There is an integrated sealed connection between the flexible bag and the hatch, to prevent stored oil in the bag from entering the tank's annulus and/or the surrounding environment. The hatch is removable and installable by means of a driverless operation.

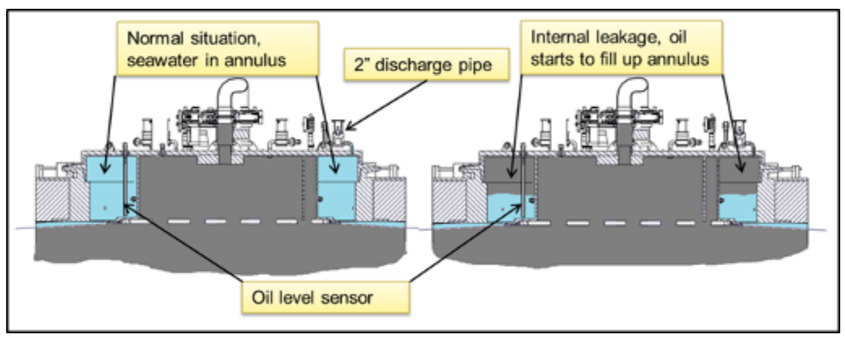


Figure 8 - Hatch detail, internal oil leakage recovery

The protection structure can securely contain all the stored oil in case of a bag rupture. In the event of an accidental oil leak through the bag for whatever reason, there will be direct contact between oil and water, but no oil will reach the surrounding sea as the protection structure will hold the entire oil volume of a full SSU bag with safety margins. The oil will be discharged by the main pipe and any remaining oil outside the bag is discharged by a separate ROV operable connection at the top of the hatch.

The SSU system is operated and controlled by the field operator as a part of the normal field process operations.

Due to the density difference between oil and seawater the oil will always fill the bag from the top and move down in a horizontal level.

Different fields will have variable storage needs and the ability to size, combine and manifold multiple SSU's provides attractive flexibility. The number of SSU's can be matched to field life production and Tail end production can be optimized.

The SSU system is a natural and cost efficient alternative to a surface based Floating Storage and Offloading (FSO) vessel exposed to the full force of nature. For a field development scenario utilising SSU instead of a FSO vessel no separate personnel are required for the SSU and hence no crew change/ helicopter transfers and other logistic issues. This provides valuable HSE benefits in addition to significantly reduced maintenance and running cost.

The flexibility and the cost savings the SSU technology offers may help commercialize development of marginal oil fields.

Figure 11 illustrates a typical field layout for an SSU application. The SSU's are connected with a topside facility with direct offloading to shuttle tanker.

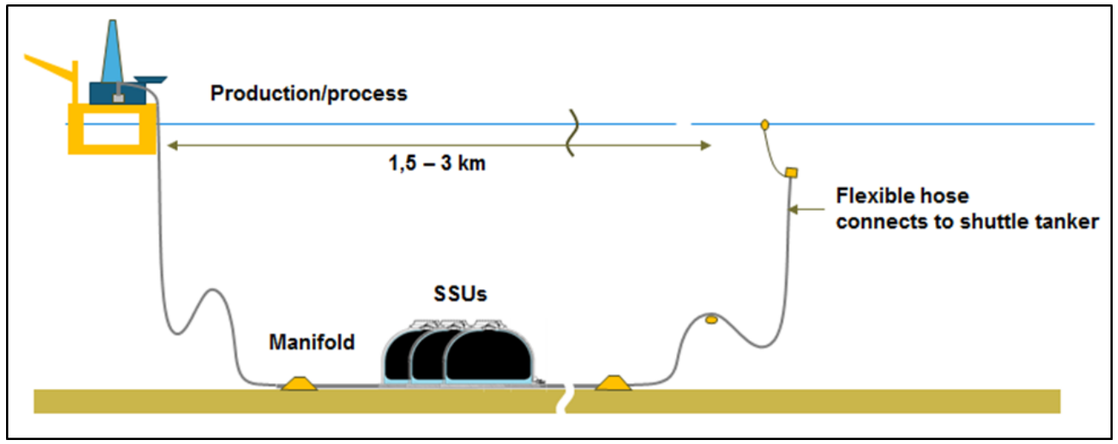
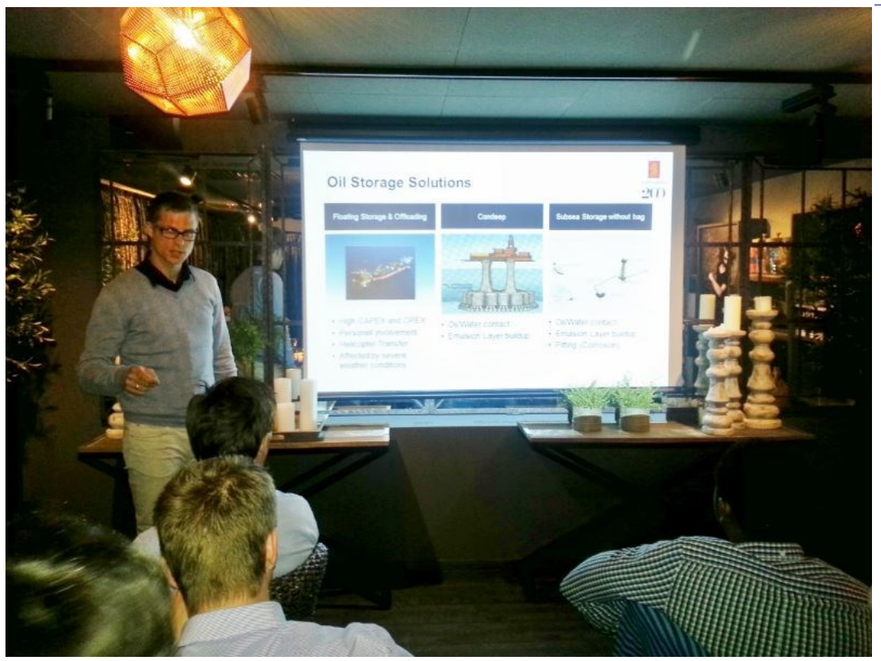


Figure 11 - SSU field layout

The trend in the Oil and Gas Industry is more and more processing subsea and reduction of surface facilities. Future complete Subsea Field Developments could be developed with SSU's as seabed oil storage and export via shuttle tankers as an alternative to long pipelines. The SSU system could also be utilised for storage of chemicals and other operational liquids. The SSU provide the vision and ability to develop remote oil fields with a complete subsea solution and export via tankers.

There are several challenges to oil production in arctic areas. The SSU with its dual barrier protection philosophy provide the ability to store oil on the seabed under the ice and out of the way of icebergs and thereby enabling alternative development scenarios.



Torleif and guests on the Lectured dinner at Olivia, April 23 2014

Should you have any questions regarding SSU, please contact

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Questions from the quiz March 26 –test your knowledge!

1

1	When was the First oil well drilled? (year)	1885	1932	1859
2	When was the first well drilled from platform?	1891	1930	1921
3	When was the First Hydraulic rock fracturing per-formed?	1972	1947	1980
4	The longest oil wells in the World: Kola Superdeep Borehole (Russia) 12,262m Maersk Oil in the Al Shaheen oil field (Qatar) 12,289 m Sakhalin-I Odoptu OP-11 Well (Russian island) 12,345 Colore the years according to colors of the "wells"	1970-1989	2008	2011
5	The 5 biggest oil filds in the Wold today are published below. Conect the oil filds and the their production rate (barrels per day) by line	*1000 barrels		

Upper Zakum oil field, located 84km north-west of Abu Dhabi Islands, United Arab Emirates (UAE), in the Persian Gulf — 180

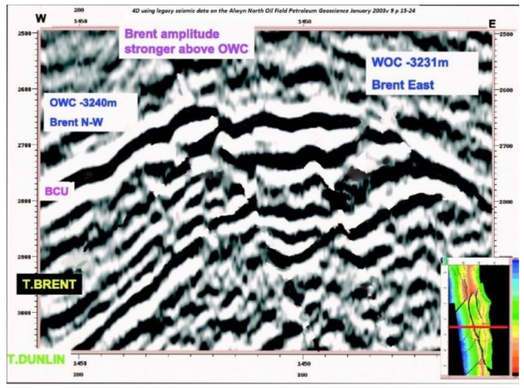
Kashagan oil field is located 80km south-east of Atyrau in the North Caspian Sea, Kazakhkstan — 500

Safaniya (Safaniya field in the Persian Gulf, Saudi Arabia) — 1500

Manifa oil field, located south-east of the Safaniya field in the shallow waters of Persian Gulf, Saudi Arabia — 1.500

Lula field, earlier known as the Tupi field (Santos Basin, Brazil). — 200

2



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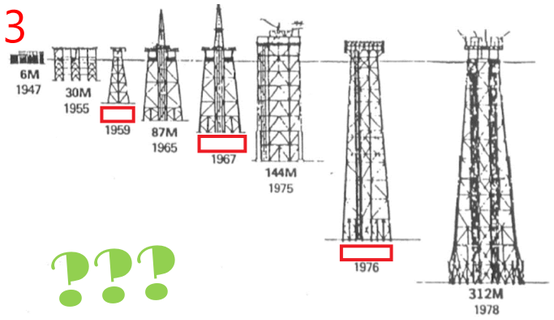

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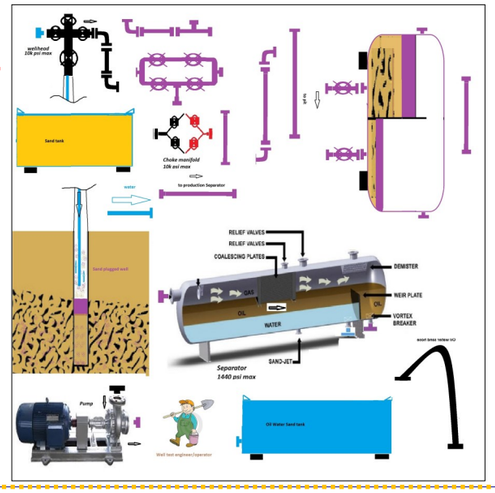

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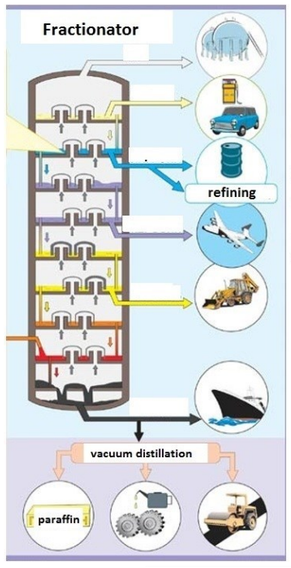


gas
kerosene
gasoil
petrol
naphtha
fuel oil

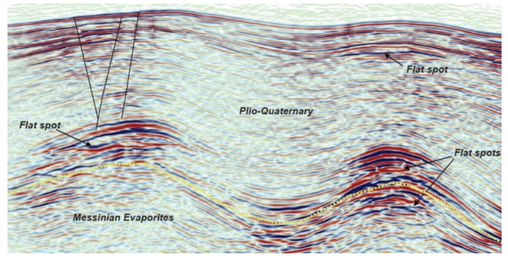
Questions

1. History
2. Define 2 faults, 3 horizons named on the picture, and 2 oil-water cuts
3. Guess the rig length progress
4. Make layout from available equipment for Well Sand Clean up
5. Define the products of each step of refinery

Answers from the quiz on January 22

Questions were published in the 1st edition, April 4 2014

1



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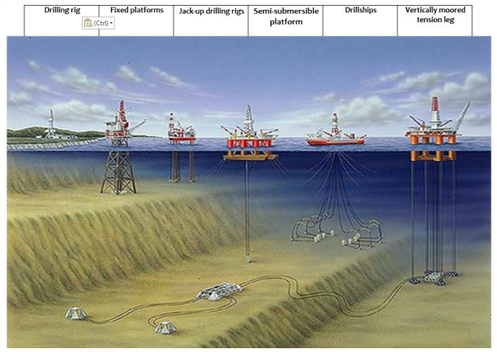

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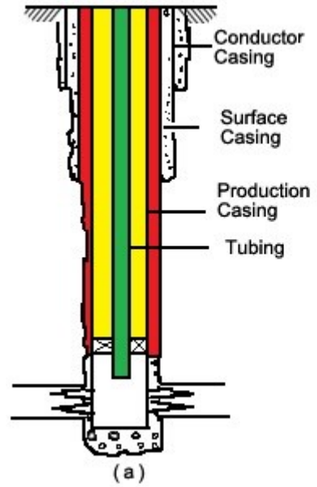

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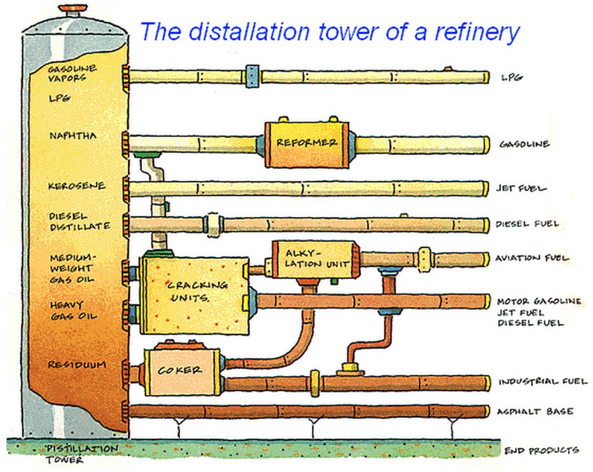

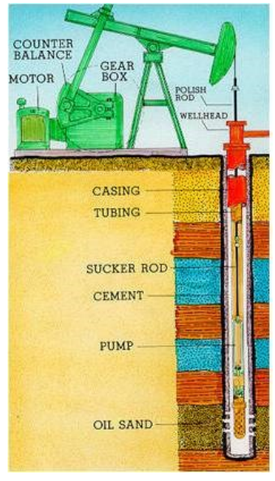

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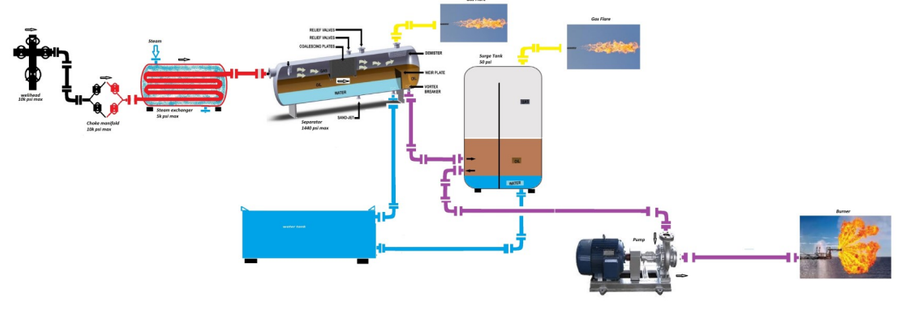


News and upcoming events

Stay connect with your section!

Read more on http://www.spe.no/stavanger/

SPE International Northern Norway

Marius Stamnes

Web & Program Chair SPE Northern Norway Section/ Lead Completion Engineer Commercial Group, Weatherford

2014 SPE Workshop in Arctic Norway video has now been released

The official video from the 2014 SPE Workshop in Arctic Norway has now been released on YouTube.

Watch it at our official YouTube Channel at: https://www.youtube.com/user/SPENorthernNorway

The 2015 SPE Workshop in Arctic Norway will be held in March 2015. The Call for Abstracts will be sent out this fall.

SPE Northern Norway Season Ending 14 May

14 May, SPE Northern Norway Section was visited by SPE North Sea Director Carlos Chalbaud. The attendees at the meeting received a good presentation by Mr. Chalbaud, where he talked about SPE both internationally and regionally, SPE's initiative towards different disciplines and young talent.

This meeting was also a good opportunity for our brand new Student Chapter to meet the North Sea Director. The Student Chapter will be a joint chapter between the University Colleges in Harstad and Narvik. With the oil industry in Harstad, the technical University College in Narvik and the pre-engineering course at Harstad University College, we believe that the synergies of connecting these together will be fruitful.

We will kick off the Student Chapter this fall with a big event in Narvik, where we plan to have presentations both from the industry and the academia.

*SPE North Sea Director **Carlos Chalbaud** and students from the SPE Harstad Narvik Student Chapter*

Photo: Inge Bjørn Hansen, Hålogaland Avis

SPE & Schlumberger Spring Games!

Edi Hasic

The President of SPE Oslo Student Chapter

This year the annual event of SPE Spring Games was successfully held on 2nd of May and we were lucky enough to have Schlumberger as official sponsor. The attendance was more than satisfying and everyone had a lot fun. The event started with an interesting presentation from Schlumberger personnel at around 17:30 at auditorium 1 of the geology department and continued with the Spring Games outdoors, behind the physics department. The weather was a little chilly, but no rain so everything worked as planned. There, members could enjoy themselves by participating in different games like limbo, tug of war etc. and were also offered free grill food and refreshments. In addition, SPE board prepared lottery for all the teams competing at the games and the winner earned a tablet as prize. Finally, the event continued in the geobasement in the form of a party, where everyone could dance, socialize and have a nice time! We heard many positive comments about the event and we hope to carry on with the tradition of organizing SPE Spring Games and do it again next year!

SPE Spring Games

Presentation by Schlumberger

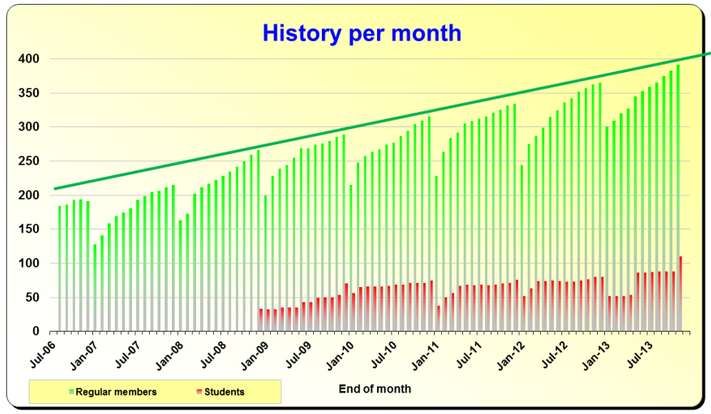
One Day Seminar Bergen 2014

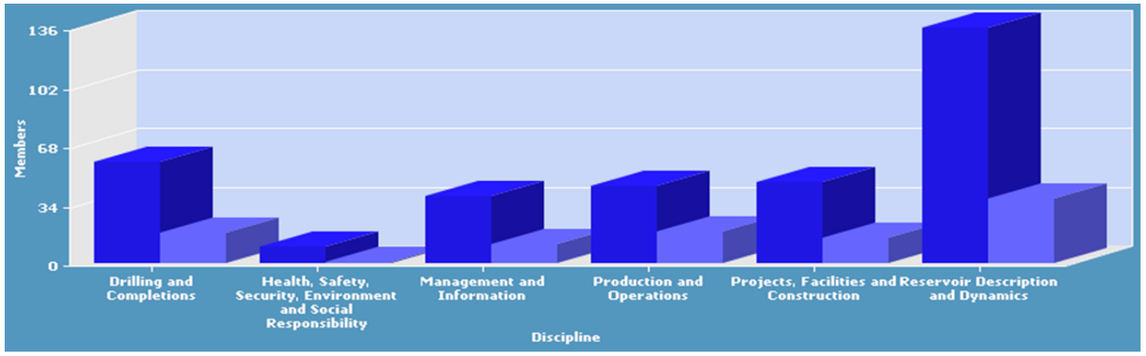
In the beginning of April, we went to Bergen to meet the other SPE Student chapters in Norway. It was just a friendly meeting where we socialized and exchanged both experiences and ideas. All of the student chapters were positive of the meeting and the plan in the future is to meet again, and hopefully continue to be closely connected. Next time we will meet in a different city where one of the other Student Chapters will organize, and this will hopefully be an annual event where we can meet in all the cities SPE students are represented."

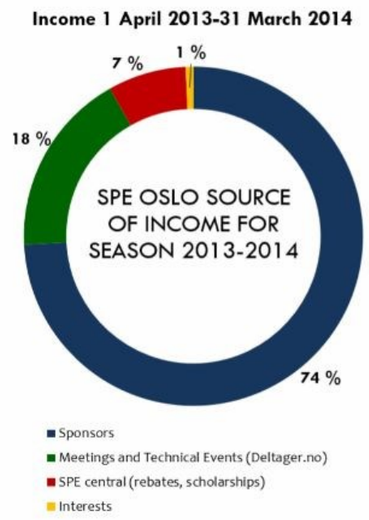
by Edi Hasic

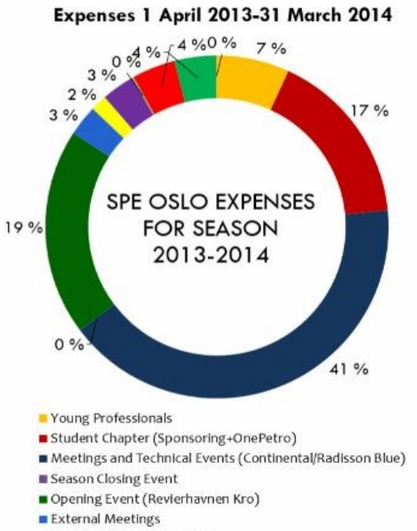
Students, together with the Mayor of Bergen, Trude H. Drevland, and the SPE President 2015, Helge Haldorsen!

SPE OSLO MEMBER TRENDS









From the Financial report of SPE Oslo section 2013-2014 season

Thank you!


Idemitsu
Petroleum Norge


SPE
International


bayerngas
norge


TULLOW
OIL


add energy


concedo


core energy


SVENSKA
PETROLEUM EXPLORATION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The energy to lead


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PETROLEUM


DETNORSKE


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