



**Using innovation to help meet the energy demand:
solutions to extract more from existing fields**

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Second Session
Webchat Transcript

Meet your panel

Dick Benschop

President Shell Netherlands

A former Deputy Minister for Foreign Affairs in the Dutch Parliament, Dick joined Shell Energy Europe in 2003. In 2006 he moved to Kuala Lumpur to oversee Shell's Gas & Power business in Malaysia where he spent 3 years. Today, he lives in The Hague with his wife and children.



Didrik Reymert

VP Shell Upstream Projects, EMEA

Didrik joined Shell directly after completing his Masters from the Norwegian Institute of Technology. His assignments have spanned planning and asset management as well as engineering projects, working in Nigeria, Oman, The Philippines and Europe.



Michael Lander

Project Manager, Shell, Schoonebeek Redevelopment Project

Since joining Shell in 1987, Michael has worked in project management, technology development and venture set-up roles across the globe. He is responsible for the Schoonebeek Redevelopment Project.



Hans Wenck

Communication Manager for Innovation, Research and Development, Shell

Hans joined Shell as a research chemist in 1992 and has fulfilled a variety of roles in project management and communications. His affinity with technology brought him to the Netherlands in 2005, where he lives with his wife and teenage children.



Diederik Boersma

Shell R&D Team Leader for Enhanced Oil Recovery

Diederik has 20 years of experience as a reservoir engineer, project manager and chief project engineer. Well versed in the challenges posed by geology, reservoir fluids and recovery mechanisms, he is R&D team leader for enhanced oil recovery in Rijswijk.



Val Brock

Shell Manager IOR/EOR

Val leads Shell's global research and innovation organisation for enhanced and improved oil recovery methods. Now based in the Netherlands, he has held various line and leadership positions including corporate planning/strategy and venture management.



Frank Jelgersma

Head of Petroleum Engineering, Shell, Schoonebeek

Frank's focus has long been on the further development of mature oil and gas fields, making him a natural choice for the Schoonebeek project. He joined Shell in 1986 and has worked in Aberdeen, Brunei, Rijswijk and Oman as well as The Hague.



Dick Benschop

Hello everyone. Welcome to today's webchat, "Using innovation to help meet the energy demand: solutions to extract more from existing fields." I'm Dick Benschop, President Shell Netherlands. I'm joined by my team: Didrik Reymert, VP Shell Upstream Projects, EMEA, Michael Lander, Project Manager, Shell, Schoonebeek Redevelopment Project, Diederik Boersma, Shell R&D Team Leader for Enhanced Oil Recovery, Val Brock, Shell Manager IOR/EOR, Frank Jelgersma, Head of Petroleum Engineering, Shell, and Hans Wenck, Communication Manager for Innovation, Research and Development, Shell.

I hope you enjoy the session and we are looking forward to your questions.

Introductory Question

Q. How do innovation and technology help maximise value from energy resources?

Dick Benschop

A. Hi,

The world's remaining oil and gas supplies are in harder-to-reach places: in deep waters, in the frozen Arctic or in rocks from which they cannot be easily freed. Human ingenuity, and technology and innovation hold the key to unlocking the energy our customers need to power their life. For example, currently the industry recovers around 35% on average from an oil reservoir. We have developed new recovery techniques that allow us to extract more oil from existing fields. By using these techniques in light oil reservoirs, an extra 5-20% can be extracted. For heavy oil the increase in recovery can be as high as 70-80%.

Introductory Question

Q. What are the key partnerships in enhanced oil recovery projects?

Michael Lander

A. EOR projects are technology intensive, needing to use or build on best practices for each application. For this are building technology networks, partnering with universities, such as the University of Delft, but also with the key service providers in the industry, such as Schlumberger. On the Schoonebeek project I'm working on, we have the technology within in-house so using the expertise from other Shell operations.

Alex Hernandez

Q. How active is Shell in supporting efforts to use capture CO₂ from CCS for Enhanced Oil Recovery?

Diederik Boersma

A. Alex, we are and have been actively looking in integrating CO₂ sequestration with EOR. We believe we need a value chain approach here. CO₂ for EOR can work for certain types of oil reservoirs very advantageously. Recovering CO₂ of the right quality from the atmosphere or from flue gas in a cost effective and energy efficient way is often difficult. Preparing the air used for power generation, removing the nitrogen, can often help to make it more attractive. We have made development proposals along these lines for the Middle East and for some offshore fields. They have not yet matured to execution decisions.

Introductory Question

Q. How can we make the most of mature oil fields?

Dick Benschop

A. Hi, there are several ways, most include various Enhanced Oil Recovery (EOR) techniques - generally involving thermal, gas flood, and chemical - that have the potential to add significantly to the amounts of oil that may be extracted from mature conventional oil fields. Mature fields account for some 70% of world's oil production and typically only 30-35 % of the oil in place is recovered by conventional production. By using EOR in light oil reservoirs an additional recovery of 5-20% can be achieved. For fields with heavy oil, the increase in recovery can be as high as 70-80%. According to EIA, oil production on stream will decline by two thirds by 2030. This means that around 50 mill. barrels of oil per day will have to be developed. EOR can play a critical role in closing this gap.

oceanresource_2

Q. In Shell's view what are the challenges around EOR using CO2 (CCS)?

Hans Wenck

A. Hi Oceanresourcean,
good question. There are quite a number of challenges related to the deployment of CO2 EOR. One is about the sourcing of CO2. Of course the obvious would be to use manmade CO2 from e.g. power plants to boost recovery. The issue is that the fields we want to apply EOR to are often far away from these CO2 sources. Secondly, CO2 EOR is not applicable to all reservoir settings but the pressure / temperature conditions need to match the requirements. The overall concept of CO2 EOR is of course appealing as it would help to reduce CO2 emissions and at the same time would allow us to increase oil recovery. We are working on the further the development of CO2 EOR based on our 15 year field experience in the Permian basin CO2 project in the USA.

tecsgi

Q. Hello, this is Sergio from Argentina.
Have you tried or plan to try any kind of pulse stimulation in order to increase recovery factor in waterflooded reservoirs?
Thank you very much.

Frank Jelgersma

A. We looked at the pressure pulsing technique but have decided not to follow it up further. There are more promising techniques that we are following up.

S. Farnand

Q. What is your view on when nitrogen would be most appropriate for EOR compared to CO2?

Diederik Boersma

A. D. Farnand,
You pose a very nice question. For EOR we are looking for injection gasses that are miscible with the hydrocarbon reservoir fluids. CO2 is miscible at lower pressures than nitrogen, some oils, due to their composition are easier miscible with CO2 compared to Nitrogen and vice

versa. The bottom line is that for specific reservoir both gasses can be tested with respect to the miscibility characteristics based on oil composition, temperature and reservoir pressure. In general though deep high pressure reservoirs with light volatile oil are candidates for nitrogen, shallower, cooler reservoirs better for CO2.

Groy

- Q. what are the likely scenarios to be considered in framing the question of debate? Is it business as usual or are considerations given to finite versus infinite sources of energy with respect to demand and supply considerations?

Dick Benschop

- A. Groy,
A big question. Demand is driven by population growth (about 9 billion people by 2050 vs. 6.7 billion now) and increasing wealth, especially in emerging economies. The world should welcome this growth in demand - it reflects that hundreds of millions of people will come out of poverty. Supply will need to match the increase in demand - both from new, often more difficult resources and by increasing recovery from existing resources. We can add the challenge of climate change to this! Please check the [Shell scenario's Scramble and Blueprints](#) as well.

Gerben

- Q. What is Shell's position on the use of renewable energy for EOR?

Hans Wenck

- A. Hi Gerben, thanks for your question. One of our R&D objectives is to improve the energy efficiency of EOR operations. For example at Qarn Alam and Amal in Oman together with our partner PDO we generate 80% of the steam injected from exhaust heat captured from local power plants. We are also looking into using concentrated solar energy for steam generation. This currently being evaluated with plans to apply it in Amal/Oman.

Marc S Young PE

- Q. What role does large corporate O&G companies see for contractors in the sourcing of technology for enhanced oil recovery. Why the insistence on retention of Intellectual Property, particularly that which may be brought to the table by the Contractor and their pool of consultants and experts with experience in the area? Does this pose a barrier to true sharing of lessons learned and best practices in the industry?

Didrik Reymert

- A. Marc
We see a key role for contractors and suppliers in developing or sourcing technology for enhanced technology, but we also invest quite a lot of money in developing our own technology in selected areas. In 2010 we spent \$1bn on research and development, more than any other oil company. Some of this money was spent on developing EOR technology. With regard to IP we see value in retaining IP, particularly when we have contributed or paid for the development of the technology. I do not think that this does represent, in practice, a significant barrier to sharing of lessons learned and sharing best practises. Shell does actively participate in various fora where these types of issues are discussed and shared, and as most of our developments are shared with one or more partners there is sharing in this way as well.

Yousef

- Q. Dear Dick, What is the difference between light oil resources and heavy oil resources in terms of density? and is it possible to provide more description on the EOR technique you developed, please?

Frank Jelgersma

- A. Heavy oil has an API gravity of 20 or lower. The density of this oil would typically be more than 850 kg/m³. There are a number of EOR technologies that Shell uses: heating up the oil by injecting steam, injecting polymers in order to improve the sweeping action of water to displace the oil and oil sand mining

Jim

- Q. What steam quality are you injecting at Schoonebeek, and why are you using ultra pure water?

Michael Lander

- A. Jim,
Thank you for your question. Let me start with the water quality. For this we have been able to extend the local sewage plant to refine the water quality by using micro filtering, osmose and active coal, effectively a process which is not using chemicals.
This water is subsequently converted into steam using the exhaust heat of the power generator. This water needs to be ultra-pure so free from any particles as they may be left behind in the steam conversion process, so effectively clogging up the equipment.
In Schoonebeek we have chosen to use superheated steam so steam that has no free water present when generated.

maxoi

- Q. I would like to ask Shell about the Mmicribial EOR, have shell used it, or nt, and their comment?

Diederik Boersma

- A. Maxoi, we are looking in microbial that in our exploratory research group. We still feel we need to mature that further in the lab to gain more fundamental understanding on its workings and in our modelling before applying. We are actively looking at this in parallel with other innovative hybrid EOR technologies.

BasKlop 2Elevate

- Q. You might have excelent technology but well and reservoir management remains a people business ... how many people are managing day to day how many wells and reservoirs in Shell? How do you ensure that the right decisions are made and therefor Shell deserves the licence to operate from the owners/governments of the countries they operate in? How do you know that Shell does this better than its competitors, knowing that poor management, i.e. loss of 1% UR is like Mr.Dick Benschop said in his introduction video not only worth a lot of money but very often also irreversible (by passed oil etc...). Look forward to hear your views on how you differ from competitors wrt WRM org.capability...?

Dick Benschop

A. Bas,

Yes - people, their qualifications and continuous training matter a lot. In our operations Wells Reservoir Management has dedicated resources to underline the focus it has. The connection to drive best practices and operational excellence is through Global Networks in a Centre of Excellence. At the same time we have a number of external partnerships.

Owen_Hehmeyer

Q. People have historically thought about EOR as a process applied late in field life ('tertiary' recovery). At that time, economics may be challenged or there may be facilities issues. What is your view on applying EOR technology in greenfield development? Is Shell planning for EOR at any greenfield developments currently?

Didrik Reymert

A. Owen,

You are right that traditionally EOR is used at late life of an oil field as 'tertiary' development. But we are now studying and developing oil fields that do require EOR even to achieve initial production. These are typically heavy oil assets that we until recently would have considered uneconomical or too difficult, particularly, as long as there were ample 'easy oil' opportunities around. But the change in oil price and recent advances in technology has indeed changed this picture.

Introductory Question

Q. Why is enhanced oil recovery a viable solution?

Val Brock

A. Appreciate the question, it's an interesting one. On average in the industry recovery factors are around 32%, meaning that 2/3 of the barrels are left behind after conventional methods to produce the oil. In part this can be due to geologic complexities, like faulting and layering of the rock that holds the oil, difficult to do much beyond drilling more wells. In addition, there are a couple of physical challenges of trying to get the oil out of the rock, and that is where EOR comes in. First, the oil can be thick or viscous, such that it does not flow to the producing wells easily. Here heat can be applied, with for example steam as in Schoonebeek, to thin the oil and enable it to flow. Second issue is that oil and water tend to be in the pore space of the rock together, and as the saying goes oil and water don't mix very well, so this creates a tendency to trap the oil. Injection of miscible gas or surfactants (i.e. soaps) can break down this "surface tension" between water and oil, again enabling it to flow. All this makes it an exciting area for technology and science to bring solutions!

steve gluck

Q. What is the range of solids content that comes up with water and oil in EOR projects and how are those solids separated?

Frank Jelgersma

A. The amount of solids that are produced with EOR projects depend on the EOR method used. Steam flood projects produce oil and water with relatively small amounts of solids. Typically

small amounts of sand will be produced. This drops out in the oil/water separation facilities and will be removed from time to time. A similar approach is used for other EOR methods like polymer flooding.

Amrit

Q. Do you see the role of nanotechnology in EOR? In the short term (say 3-5 years), are there any projects in scope?

Diederik Boersma

A. Amrit, I like your question. Indeed we are looking into nanotechnology for EOR. Currently in exploratory research we have a number of different projects on nanotechnology. It is mainly related to improving mobility control in both water and gas flooding.

sudhir

Q. Innovation and technology are the key to the process of maximising returns in today's scenario; the technology available till yesterday was able to provide productions and recoveries to a limited extent, however, innovation would lead to enhancement in recoveries and more importantly by way of improving the process chain itself.

Dick Benschop

A. Hi, I certainly agree and hence our focus on technology and innovation.

DaleB

Q. Maybe this is too much off-topic, but I'll throw it out there ... What is Upstream's long term commitment to renewable energy resources (ie. Wind) as part of the "Using innovation to help meet the energy demand"?

Frank Jelgersma

A. Upstream's commitment is to minimise the energy use in the oil and gas production process. If there is an economical opportunity to use renewables in the extraction process, this is usually pursued. Shell Upstream core business is oil and gas extraction. In other parts of the Shell organisation renewables are being worked (most notably biofuels).

dcotov

Q. I have a couple of questions to Mr. Wenck,
How does Shell develop innovative solutions in EOR? Using internal R&D organization?
Outsourcing to global service providers? By investing through the Shell Technology Venture Fund?
How does Shell protect its solutions? Applying for patents? Secrecy? Complexity? Or through economies of time?
Finally, does Shell cooperate with other "majors" to develop new EOR methods or innovations on a whole?
Thank you in advance!

Hans Wenck

A. Hello Dcotov, thanks for your questions - seems you want to keep me busy...
EOR is one of our top priorities in R&D. We develop novel EOR techniques in-house in our RD

laboratories and we also collaborate with research institutes and universities e.g the Technical University of Delft and the Texas State University. To my knowledge we do not use the Shell Technology Venture fund in the EOR space.

IP protection is typically done by filing patents and FYI Shell overall hold some 30,000 patents incl. EOR technologies.

We partner with other majors in many upstream projects hence improve specific project related technologies but there are no major R&D collaborations on EOR in place.

Michael

- Q. EOR, especially steam injection is old tech. I worked with Getty and Texaco in the Bakersfield, CA area in the early 1980s on this technology. What could be new in this field, unless you include horizontal drilling?

Val Brock

- A. Thanks for the question Michael, and you of course are right that there are some EOR techniques like steam injection and CO2 flooding that are well known and proven in Shell and the industry. An area that is less mature, but holds great potential, is chemical EOR. This involves the injection of for example polymers to thicken the injection water or surfactants (soaps) to clean the rock of the oil trapped in the pores, much like washing it off of our hands.

EOR is also about technology integration, so as you mention advances in areas like wells, reservoir simulation, and surveillance can also unlock new fields for EOR.

mmurugesu

- Q. What are your views on downhole steam generators for heavy oil recovery and the effect of the injected nitrogen and CO2 on recovery?

Michael Lander

- A. mmurugesu,
I like your approach! Generating the heat where it is needed moves us away from transportation cost and losses.
In Shell we are carrying these type ideas to see where they can be applied. CO2 injecting is already used as a EOR technique and we are piloting nitrogen injection to enhance hydrocarbon recovery.
So you are not far off the mark with your ideas.

DIKDAN

- Q. which is the most prominent region or country that Shell plan to invest the most in oil recovery from existing fields ?

Hans Wenck

- A. Hello Dikan,
We have a portfolio of 11 EOR projects in development or in operation including projects in the Netherlands, Russia, Oman and Brunei. We have more than 20 on the way in various maturation phases. Our experience has been gained in projects in different geological, geographical and commercial settings and challenges around the world. Going forward we will apply EOR where it will generate value. Unfortunately we can't share specific investment figures per country/region.

aranyabhaduri

- Q. Greetings MR. Dick Benschop and other Shell team members, and thanks for starting this webchat. We have seen your video posts on Dutch Schoonebeek project and others. Do you have any specific examples for offshore production (esp deepwaters?)

Didrik Reymert

- A. Aranyabhaduri
Thanks for your question ... indeed we are working on developing deepwater heavy oilfields. In 2009 we brought on stream the Parque das Conchas ultra deep heavy oil development off the coast of Brazil. This project applied some innovative technology. We installed powerful electrical pumps on the sea bottom to push the oil to the surface nearly 1800 mm above. The oil would not have flowed to the surface by itself as it does in conventional offshore oil fields. We also recently applied the same technology in the Perdido project in the Gulf of Mexico, in even deeper waters.

Ivo Kraeger

- Q. What is the need for surfactant and/or polymer recovery techniques today and in the next 5-10 years?

Diederik Boersma

- A. Ivo, Thanks for the question. It is a technology dear to my heart. With Shell we are currently looking for active field trials/implementation in four fields in four different parts of the globe. When these surfactant polymer floods bear fruit, I believe there might be a snowball effect. On pure polymer flooding we are injecting 100.000 bln/d polymer solution in phase 1 development of a middle eastern field. Initial results are very promising indeed.

johann Philippe Tchotch

- Q. I have seen few questions related to the point of what should be used for injection steam for EOR , whether it would be chemicals , gas or CO2 , but i miss the general criterias (temperature , reservoir pressurs ,oil composition ???) as in front of an aged field to decide what is the most appropriate elements being used for EOR ???

Michael Lander

- A. Johann Philippe,
Indeed each technique has its application and the reservoir features determine which technique is used when. There are no hard criteria as it is also often a mix of the criteria's you are naming.

Mark Beckett

- Q. Regarding enhanced recovery methods for unconventional gas, has Shell published or communicated a position white paper on the various challenges and benefits in this area, or in comparison with enhanced oil recovery methods.

Dick Benschop

A. Mark,

We have published our principles with regard to [Onshore Tight/Shale Oil & Gas Operating Principles](#).

Our principles are underpinned by a deliberate focus on safety, continuous improvement, collaboration with regulators and engagement with local residents where we strive to be open and transparent about how we operate and the impacts of our activities. We support regulation consistent with these principles, which are designed to reduce risks to the environment and keep those living near our operations safe.

Introductory Question

Q. What innovative solutions is Shell delivering to extract more oil?

Didrik Reymert

A. Actually we are working on the whole range of EOR techniques covering all three families of EOR: thermal, miscible gas injection, chemical EOR. We have also gained field experience in all of the above. In our R&D work we focus on two areas: to further improve the efficiency of EOR techniques and also to develop new techniques. In the latter category I'd like to mention Designer Water Flooding. This about increasing the sweep efficiency by adapting the salt content of the injected water to the conditions found in the reservoir. We are also working on new, more efficient polymers for chemical EOR (polymer flooding).

RJ

Q. What new methods is Shell considering or has already implemented for improving the extraction of bitumen from its operations in the Canadian oilsands?

Frank Jelgersma

A. Bitumen can be produced from larger depths by drilling wells and mobilising the heavy oil or bitumen by steam injection. Shallower bitumen resources can be mined. Alternatives that are being investigated are upgrading the oil while it is still in the subsurface by heating it with electrical heaters.

Marc S Young PE

Q. Studies have been done on the recovery of oil from the residual oil zones of West Texas using tertiary CO₂ miscible flooding. Metzger for the US DOE These studies have concluded that there is about 18 Billion barrels of oil still to be recovered using these methods. Key issue is availability of high purity CO₂ for the floods. Most of the current CO₂ used is being provided from naturally occurring high purity CO₂ fields like McElmo Dome, Seep Mountain and Bravo Dome which are from volcanic origin. What are the challenges of using CO₂ from lower quality sources like coal plant exhausts and is it even viable?

Val Brock

A. This question really strikes a chord with me Marc, because it hits home to some exciting times I had working to develop the residual oil zones for Shell in the Denver Unit of W. Texas. It is much the same technique as CO₂ flooding applied after water flooding, going after that remaining oil. As you say, availability of affordable CO₂ is an important enabler, and Shell was fortunate to discover and develop the McElmo Dome CO₂ source field to supply the many CO₂ floods in the Permian.

There are indeed technologies today to capture CO2 from industrial sources like power plants, the challenge is to drive down the cost of capture. This can be achieved through implementation and replication, basically an industry learning curve that would take costs out just like we've seen in drilling and other areas.

E.V.O.

- Q. Most people think the world is running out of hydrocarbon energy and have never heard of EOR. How do you respond to proponents of Peak Oil? What is Shell's official position and are you involved in educating the public on the real status of global oil and gas energy reserves?

Dick Benschop

- A. We publish our energy scenarios and actively engage around them and the challenges they pose. Supplies will have to keep with the strong increase in demand for oil and gas, but the world is not running out of oil and gas soon indeed. Please have a look [here](#).

steve gluck

Thanks for the public dialog.

Dick Benschop

Steve,
Good to hear!

DIKDAN

- Q. In Shell, What is the experience using steam for EOR.

Michael Lander

- A. Dikdan,
Shell has been pioneering steam injection in California already in the 1930. Applications are in the US, notably the Belridge Field in which Shell is a partner, but there are also developments in Canada. We furthermore apply steam injection in Oman and more recently in Europe in Schoonebeek.

Oscar Abbink

- Q. Dear all,
Real-Time monitoring may be considered as one of the key enablers in production optimization. As you stated Shell invest in its own technology development, but third parties also develop technologies around Real-Time, such as Microsoft, SAP, OSI PI. To what extent is Shell looking at these technologies?
Thank you, Oscar

Diederik Boersma

- A. Oscar, thanks for the question. Indeed real time field optimization is key to improve the efficiency of these costly EOR processes. That is the reason that we are actively researching real time surveillance, sensing and control. We also collaborate with the external world on this. We constantly monitor what developments in this field are. Collaborations we are in is amongst others with Schlumberger, IBM, Technical University of Delft. The TU Delft

collaboration is on Quantitative Reservoir Management where we look at real time field optimization: field sensing, simulation and model optimization, field control.

Ivo Kraeger

Q. With 2/3 of the oil still in the fields, how will successful EOR influence the oil price?

Dick Benschop

A. Ivo,

Oil prices are impacted by global supply and demand and global energy demand is expected to double by 2050, as the world's population soars and more people gain access to energy. At Shell we are working to help meet this challenge responsibly by delivering more energy, cleaner energy and helping our customers to be more energy efficient. A range of sources will be needed to meet rising global energy demand over the coming decades. We believe that renewable sources could provide 30% of the world's energy by 2050. But fossil fuels will still meet the bulk of energy demand. We see EOR as an opportunity to maximise ultimate oil and gas recovery and maintain production for longer from existing reservoirs thereby helping to meet this challenge

Owen_Hehmeyer

Q. Steamflooding and Cyclic Steam Stimulation are basically old, proven technologies, but ones we are getting better at still. I read on your web page that Schoonebeek was enabled by 'new' technology. What new steamflooding technology is being at Schoonebeek?

Frank Jelgersma

A. Steam flooding is indeed a classical method of oil extraction. The new technologies that enabled the redevelopment of Schoonebeek are: **new drilling techniques that allow us to drill horizontal wells in the oil bearing rock with great precision, **using a novel type of high efficiency/high volume pump units to pump the oil to the surface, **the use of high resolution seismic data to make a model of the oil bearing rock that is accurate to within 5 meters, **using large and fast computer models to predict the production performance of the steam flood, the use of a specialised new type drilling rig to drill the wells efficiently and cheaply, **the of a Combined Heat and Power unit to generate both steam and electricity. All of these elements have helped reduce the "footprint" of the project in terms of land use, emissions and cost.

pk47

Q. Is there a distinct difference in EOR for offshore oil fields as opposed to land-based oil fields?

Didrik Reymert

A. PK47

Whilst the EOR techniques may be that same, there are indeed some difference in offshore vs. onshore EOR particularly driven by the physical constraints we face offshore. I see several challenges for offshore EOR, cost and environmental performance being key ones. EOR generally require quite extensive facilities and complicated treatment of the oil, which is a lot more expensive to install offshore compared to onshore. Also EOR will increase water production, and offshore treatment and disposal of big volumes of water is a challenge. When EOR is applied to existing facilities, normally late in the field life and as an extension of the original design life, there will be the normal challenges about maintaining structural

integrity of the facilities, weight control and extension of design life etc. Offshore EOR will also generally result increased logistics and maintenance.

Dklein305

Q. Hi Mr. Benschop, where does Shell stand on using CCS technology in the EOR field?

Val Brock

A. Hi Dklein, hope you don't mind me offering an answer.
Shell views "pure" Carbon Capture and Storage and CO2 EOR and slightly different but very complementary technology areas. Given the size of the challenge and the distribution of storage candidates, saline reservoir storage is expected to be the more widely applied solution. However, where there are situations where a good CO2 EOR candidate is reasonably near a CO2 capture site, then these can be niche win-wins were EOR may be able to provide a jump start to for example getting the necessary CO2 infrastructure in place. Appreciate the interest in finding synergy in these two important areas!

Ruxandra

Q. Dear Mr Benschop,
I've read with great interest the questions and answers on the forum.
Thank you very much if you can answer to my questions:
What are the most used EOR techniques? Does Shell have specific innovative EOR techniques, or that techniques are common for almost all oil companies?
What is the potential of EOR, compared with new discoveries and compared with unconventional reservoir reserves? What should we focused on?
Kind regards

Hans Wenck

A. Dear Ruxandra,
thanks for joining the chat.
Generally we have three families of EOR: Thermal, miscible gas and chemical injection. The most widely used technique is thermal recovery using steam injection. Chemical EOR is probably the least used method across the industry but we see a promising future for e.g. polymer injection.
EOR is one of the key themes on our R&D agenda focussed on two main areas: further improving the efficiency of EOR techniques and also developing new techniques. In the latter category I'd like to mention Designer Water Flooding. This about increasing the sweep efficiency by adapting the salt content of the injected water to the conditions found in the reservoir. Designer water flooding proved to significantly increase the recovery factor. Another example I'd like to mention is our work on new, more efficient polymers for chemical EOR (polymer flooding).

Dantay

Q. HI Daniel Taylor from Brazil here, Could you reveal a general \$ cost of deploying the EOR technology used at the Schoonebeek field, in terms of re-operationalizing the wells? This would be useful simply to get a general understanding of the costs of applying these EOR techniques to similar fields around the world.

Michael Lander

A. Hi Daniel,

Thank you for your question. \$ for deployment are important as they drive the EOR theme. I'm pleased to say that the Schoonebeek Redevelopment project has a viable business case, but hope you understand that I cannot provide specific cost data

Aditya.S

Q. How shell is different from other upstream companies in terms of application of technology in EOR and corresponding R&D?

Dick Benschop

A. Aditya,

In 2010 we spend over 1 billion US\$ on research and development overall - on a range of key topics and challenges, including EOR. We are leading amongst the major IOC's in developing technology for the future.

Owen_Hehmeyer

Q. Are you going to archive and make available the contents of this web chat?

Hans Wenck

A. Hi Owen,

of course the full transcripts will be made available on Shell Dialogues soon. We'll send you the link later.

Surasani

Q. Microbial Enhance Oil Recovery known from many years with over few hundreds of patents and more environmental friendly than other EOR techniques, but why Microbial EOR is not readily acceptable to oil industry?

Diederik Boersma

A. Surasani, this is a recurring intriguing question. We are looking into Microbial EOR on a research scale. We are aware of the patents and field trials done in the industry. Currently we see the risk of applying it to our oil reservoirs larger than the benefits. Microbial EOR requires nutrients to be injected to the reservoirs to feed the microbes. These nutrients might also wake up undesired microbes that can generate nasty toxic gases like H₂S or may cause reservoir plugging. In short we are looking into it and monitoring what is happening in the industry, currently we don't believe the technology is mature enough to apply to large oil fields.

Yousef

Q. Does converting the oil underground contribute to EOR? in addition, is the production tubing line (Casing) insulated that it allows no heat loss or gain between the oil flowing and the earth? How long is it typically and what do you monitor its temperature?

Frank Jelgersma

- A. Converting oil in the underground can be considered EOR, because it significantly increases the volume of oil that can be extracted. In projects where we produce oil with a steam flood the annular space between the injection tubing and the cemented production cases will typically be filled with nitrogen to prevent heat losses as much as possible. The well length depends on the depth of the resource; this could be hundreds of meters or up to several kilometres. Temperature monitoring can be done in several ways: **monitor the temperature of the produced fluids when they come out of the well, **monitoring the downhole temperature with a glass fibre (Distributed Temperature Sensing = DTS), **carrying out temperature logs on wireline. In the case of steam floods there is a relation between pressure and temperature. In those cases pressure measurements give a good indication for temperature as well.

Cristobal Romo

- Q. Hello, I would like to know how much money Shell spends in R&D specifically in EOR or where could I find this information. Thank you

Dick Benschop

- A. Cristobal,
We do not disclose the specific amount spent on EOR/IOE.

Groy

- Q. Can you please summarise the key learnings arising out of the debate and circulate to participants?

Hans Wenck

- A. Hi Groy,
The transcripts will be made available on the Shell Dialogues website soon after today's sessions.

Alex Hernandez

- Q. What will be the minimum price per barrel to guarantee the financial viability of EOR of heavy oil 5-10 API.

Dick Benschop

- A. Alex,
Across our portfolio we have a range of projects, each with specific characteristics. All our projects are evaluated against a range of prices and there we use prices between \$50 and \$90 where the economics of an individual project need to meet specific criteria.

Aranya Bhaduri

- Q. Didrik Reymert, Thanks for your informative reply on deepwater/ultradeepwater cases. Could you throw some light on the role of EOR/IOE challenges in DW/UDW cases? Also, as discussed earlier during this webchat, do you have any example where you have employed innovative solutions integrating EOR/IOE in the initial phases of field development and specifically for deepwater/ultradeepwater cases? Thank you very much for your response.
Aranya Bhaduri

Didrik Reymert

A. aranyabhaduri

I see several challenges for offshore EOR, particularly cost and environmental performance being key ones. EOR generally require quite extensive facilities and complicated treatment of the oil, which is a lot more expensive to install offshore compared to onshore, even more so DW/UDW. There are also flow often assurance challenges associated with the water depth. Also EOR will increase water production, and offshore treatment and disposal of big volumes of water is a challenge. When EOR is applied to existing facilities, normally late in the field life and as an extension of the original design life, there will be the normal challenges about maintaining structural integrity of the facilities, weight control and extension of design life etc. Offshore EOR will also generally result increased logistics and maintenance. In both the examples I mentioned in my previous answer we did indeed apply the innovative heavy oil technology from start of initial production.

will.hickman

Q. What effect does oil price have on Shell's EOR projects?

Dick Benschop

A. Will,

Across our portfolio we have a range of projects, each with specific characteristics. All our projects are evaluated against a range of prices and there we use prices between \$50 and \$90 where the economics of an individual project need to meet specific criteria.

Marc S Young PE

Q. I have been in this business for over 30 years. I saw a big increase in EOR in the late 70s and early 80s as a response to the Arab Oil embargo and the Iran crisis. It seems that the EOR laost a bit of ground after the Deepwater discoveries in the Atwater Fold was made. Is the current shift back to EOR caused by the US moritorium on Deepwater that defacto is still in place and if that changes will it see a retreat again.

Diederik Boersma

A. Marc, thanks for the nice question. I have been through the EOR ups and downs as well. I believe the quest for EOR will continue this time. The reason is that easy oil is gone. New exploration and brown fields are getting more and more expensive. So unit cost per barrel for EOR in existing fields approaches the cost of entering new acreage.

Tuff

Q. Tertiary methods of recovering are known since the late 70ies or are still older, I don't know. How these methods developed in the last decades? When will we have "fourth methods" ?? What's the state of the art?

Didrik Reymert

A. Tuff

A very good question. As an innovative company we are looking at several other options for EOR, but this is still in advanced stage of research

ravijois

Q. Hello

1. What is the scope of Shell and other partners in Enhanced Oil Recovery
2. What other partners get to do in this programme?
3. In what way Shell promotes other partners to help achieve this goal?
4. Who are these partners and is Shell open to new partners in this programme? if yes what are the individual aspects of interests where Shell is looking out for help? Who should be approached in order to build the relation?
5. Who is the contact person in Alberta Canada?

Val Brock

A. It's an interesting question. Shell has a large global portfolio of EOR projects, with various venture partners. Shell operates many of these directly, and in some it is an incorporated joint venture where Shell may be a technical advisor. We work with our partners collaboratively to develop and apply EOR, and often to build and transfer capability. We also work with service companies where we see a strategic combination in capabilities or technologies can create more value.

Thanks for the question, and the best way to reach the right contacts in Alberta is through the following [link](#).

Tuff

Q. Dear sirs! As I know, the actual middle recovery rate of oil fields amounts to only 30 to 35 %, isn't it or it is even higher? My question is what do you think is possible in the future, for example give us a projection for 2020, 2030, 2040 and so on, if possible. Don't forget the Brazilian sub-salt (I'm living in Rio), tar sands, tight gas, all these wonderful things who will better the situation of so many people - if the politicians are able to do a good job...!! And a particular question: Is Hans Wenck German?

Hans Wenck

A. Hi Tuff,

Thanks for your question. Hans Wenck is German indeed ... Today the average global recovery factor for oil is 35 %. It continuously improved over the years because of advancements in technology. We expect the recovery factor to further increase in future. EOR technologies are expected to help extract additional 5 to 20% of the oil in place. Depending on the reservoir recovery may be as high as 50 to 70% or sometimes even beyond that. Unfortunately I can't give you a detailed prediction on how the recovery factor will evolve over the years.

BasKlop 2Elevate

Thank you for your time / opportunity to share your views ... hope public will be able to read the discussion of this one and the one of this morning again at a later stage ... much success with your endeavours ..Bas Kloppenborg www.2elevate.com

Pavo

Thank you, nice job!

Oscar Abbink

Thank you for a very informative session, much appreciated. Oscar Abbink

John Poteet

The answer provided by Mr. Wenck to Ruxandra was fascinating. It is exactly the kind of intro that those of us who want a n overview would like to see more of. If he is able perhaps someone in his office could produce a primer on the subject. Thank you for this learning opportunity. No reply expected

nimitee

- Q. My question is how does shell intend to assist smaller growing industries in the natural gas utilisation for clean power generation

Frank Jelgersma

- A. Shell provides natural gas to the market at competitive prices. Depending on the market, different gas qualities will be on offer and industrial users can select the most competitive gas for their use.

Aditya.S

- Q. In what way is shell active in extracting hydrocarbons from unconventional sources especially shale and gas hydrates?

Frank Jelgersma

- A. Shell is active in defining projects for the extraction of oil and gas from unconventional reservoirs such as shales. Shell has looked at the possibility to extract gas hydrates, but there are currently no plans to pursue this.

Dick Benschop

Everyone,
Thank you so much for joining us today. We hope you enjoyed the webchat and that we've provided answers to some of your questions. The team really enjoyed reading your thought-provoking contributions and suggestions.

We would be grateful if you could let us know what you think of the webchat [through this short survey](#). We welcome your thoughts and suggestions.

Finally, if you'd like to continue the discussion please visit the Shell Dialogues [forum](#).