GullfaksVillage 2011

NTNU - Experts in Team (EiT)

Improved Oil Recovery from Gullfaks Sør Statfjord

Presented at IPT, NTNU on January 19, 2011

1. Introduction

Since production start in 1986, Statoil has worked to increase the amount of recoverable oil volumes from the Gullfaks license through new technology programmes and improved reservoir management. The term IOR for Improved Oil Recovery is widely used for this work and IOR is also the key concept for the GullfaksVillage. IOR-projects draw expertise from across the whole Statoil organization and the experts are working together in teams. The GullfaksVillage will use a similar work process with a goal to develop innovative recommendations that could increase the oil recovery by 10 % from one of the fields in the Gullfaks area.

As a part of the Experts in Team concept, Statoil has installed a Gullfaks database at NTNU, and will update the database with main focus on the assignment for 2011. Furthermore, the students will be invited to one day at Statoil's offices at Sandsli, Bergen where additional information will be provided. The students will have an opportunity to discuss the challenges with personnel that work with these issues in Statoil.

Figure 1 shows the Gullfaks area where the main Gullfaks field came on production from the A-platform in 1986 with pressure maintenance from the start. As of yearend 2010, the Gullfaks main field has produced 355 MSm^3 which is 58 % of the volumes originally in-place. The ambition for Estimated Ultimate Recovery (EUR) is 400 MSm^3 which represents close to 70 % recovery.

The Norwegian Petroleum Directorate (NPD) has an IOR-award in order to recognize licenses, companies, projects or individuals that have created additional value on the Norwegian continental shelf through brave IOR-actions and plans. For the year 2004, the Gullfaks licence won this prestigious award

In addition to Gullfaks main field there are six satellite fields: Gullfaks Sør, Rimfaks, Gullveig, Gimle, Gulltopp and Skinfaks (Figure 1). Production from the first three satellites started in 1998, while Gimle came on stream in 2005 and Gulltopp and Skinfaks in 2007. The reservoirs are similar for all fields in the Gullfaks area, but the satellite fields contain more gas than oil – often with a significant gas cap. On the Beta ridge a large aquifer is also present providing some pressure support.

The challenge for the GullfaksVillage 2011 is to propose measures that can increase the oil recovery from the western flank of Gullfaks main field – the so called Beta ridge where the several satellite fields are located. Tordis is located outside the Gullfaks licence, but is a part of the Beta ridge.

The assignment for the GullfaksVillage2011 consists of two parts, where the first part shall be solved by all groups. The second part is different for each group. The groups must obtain knowledge of the Gullfaks history and understand the IOR-challenges for the western part of the field. This knowledge should be the basis for evaluating IOR-measures and provide a recommendation based on own ideas supported by technical analyses. The groups should work independently, but are advised to draw on the advisors available in Statoil and NTNU.

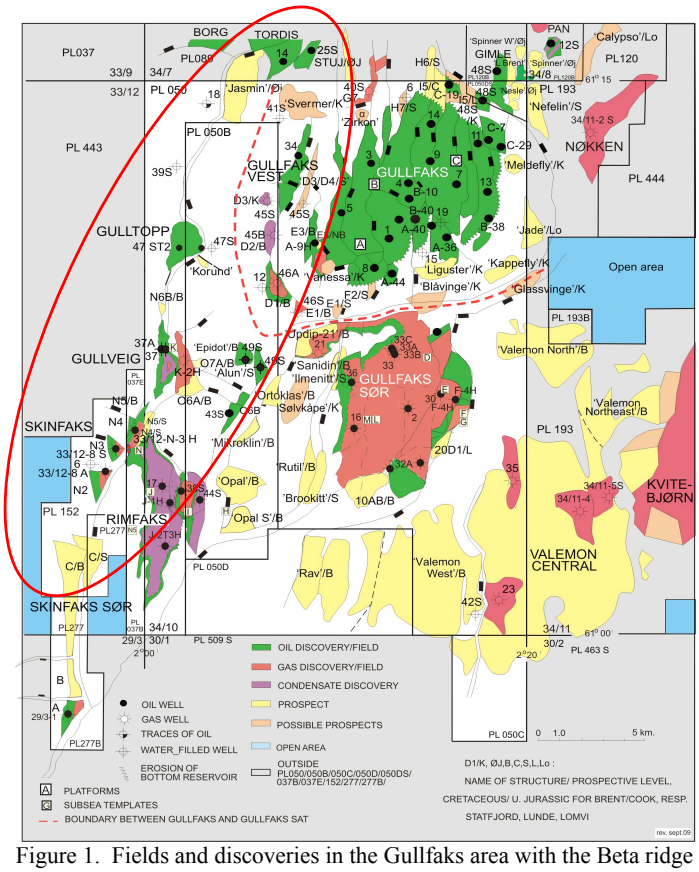

Figure 1. Fields and discoveries in the Gullfaks area with the Beta ridge marked.

2. Visit to Statoil in Bergen on 9 February

Prior to the visit, all students should have finished part A of the assignment and have reviewed relevant information in preparation for part B. Reports from earlier Gullfaks villages may be relevant. After the visit in Bergen, each group should submit a brief report to Statoil containing:

a) A very short summary of the visit and main observations.
b) The final description of part B of the assignment.

3. Statoil's role

All required information will be provided by Statoil from the presentations, from the Gullfaks Reservoir Management Plan (Ref. 1) and the visit to Statoil. In addition each group will have a contact person in Statoil that can be consulted as a supplement to the team at NTNU. If necessary, a representative from Statoil may participate on one of the village-days to answer questions and address issues that need more explanation.

The challenges provided by Statoil shall be the basis for a technical report from each group. Statoil will participate at student presentations of the final results and provide input to the evaluations of the student reports.

4. Milestones

Milestones for GullfaksVillage 2010 are:

Milestone	Task	
January 19	Statoil will presents current challenges at Gullfaks	Presentations in Auditorium
February 2	Part A of project complete	Submitted to NTNU
February 9	Visit to Statoil	Presentations in Bergen
February 16	Report from visit to Bergen. Finalise assignment part B.	Submitted to Statoil
April 13	Student presentation of the results and posters	Presentations in Auditorium

5. GullfaksVillage 2011 task

All the groups should solve part A of the challenge. Under part B there are six different challenges – one for each group.

Part A (Should be solved by all groups) **(Weight 30%)**

The GullfaksVillage 2011 has a focus on IOR on the Beta ridge on the western side of Gullfaks. The fields Gullveig, Tordis and Skinfaks are developed by sub-sea wells, while Gulltopp is a long 10 km well drilled from Gullfaks A. The Beta ridge at Gullfaks is shown on Figure 1. Information about the field will be presented by Statoil and can also be found in the RSP07 (Ref. 1). Where there is not enough information, the group should clearly describe the assumptions made. Such assumptions should preferably be reviewed with either the advisors at NTNU or Statoil. Statoil advisor for Part A is Petter Eltvik.

The main purpose of Part A is to demonstrate an understanding of the challenges related to production with pressure depletion and aquifer support. Based on information provided in part A, the students shall do material balance calculations as a basis for analysing production and pressure behaviour. The procedures to be used are shown in Attachment 1, and the data to be use are shown in Attachment 2 to be used to calculate pressures along the Beta ridge:

1. The students shall convert all oil, gas and water volumes to reservoir conditions at 2500 m MSL TVD.
2. Based on the data provided, the students shall calculate the average reservoir pressure depletion at the Beta ridge.
3. Measured reservoir depletion in wells A-32 drilled to the Beta ridge is shown in Attachment 3. Compare this to the calculations under 2 above, and comment on reasons why there are differences between the calculated and the measured pressure.
4. Make an evaluation if the recovery factor for the various fields to date. How do the fields interfere with each other? Based on the production to date, what are expected recovery factors over the full production life for the fields? Why could there be differences between the different fields?

Eltvik, Petter 18.1.11 13.27
Deleted: fields.

[redacted]

Part B (one challenge for each group) **(Weight 70%)**

Challenge 1. Geological and geophysical uncertainties – Statoil advisor: Kristian Tveiterå

A significant geological uncertainty on the Beta ridge is communication in the underground Fm. is the continuity between sand bodies.

1. Discuss geological factors that lead to the good communication in the Beta ridge.
2. The group shall make a simulation run where the transmissibility across all faults are set to zero
3. Increase the number of wells to increase the oil recovery.

Eltvik, Petter 18.1.11 13.27
Deleted: ..

Challenge 2. Drilling of a long reach water injector – Statoil advisor: Johan Eck-Olsen

A new water injection well to the Beta ridge is being planned from the Gullfaks B platform. Planning the well is ongoing.

1. A good well project is often "drilled on the paper" before initiated offshore. Describe a possible route from "drilling the well on paper".
2. The drilling industry has the last 5 years established remote expert team onshore.
3. Describe how the Statoil should perform the expert team solution. Make a recommendation about which measures Statoil need to take in order to be able to drill these wells to Gullfaks Sør Statfjord.

Challenge 3a. PLT in Gulltopp – Statoil advisor: Knut Müller

Gulltopp is a 10 km well drilled from Gullfaks A platform. The well had water breakthrough after two years of production and it is now desirable to find out from which zone the water is coming.

1. Explain the PLT technology and how a Production logging tool (PLT) can improve the oil recovery at Gulltopp.
2. Plan a detailed PLT job for Gulltopp. *(This includes simulations and detailed PLT procedure)*
3. Make a cost estimate based on information from vendors, and show economics before tax including Net Present Value.

Challenge 3b. WL operations bellow the rig on GF. – Statoil advisor: Knut Müller.

The three Gullfaks platforms have two shafts with wells. Well operations and drilling can then work independent. When production wells has to be shut in due to barrier problems on the same shaft as drilling is doing their work, it would be beneficial to secure this well properly without stopping drilling operation.

1. Explain equipment for rigging up WL bellow the rig.
2. What are the main issues for running WL bellow the rig?
3. What are the financial benefits of running WL bellow the rig?

Challenge 4. Improved oil recovery with WI – Statoil advisor: Petter Eltvik

It could be possible to stabilize the decline in reservoir pressure to improve the recovery factor for all fields along the Beta ridge by water injection (WI).

[redacted]

1. Use the Western Province (WP) model to determine how much extra water injection along the Beta ridge would be required to stabilize the reservoir pressure decline.
2. Estimate the cost of drilling the required WI wells.
3. Make an estimate of the additional recovery the increased pressure will give for all fields along the Beta ridge.
4. Make a recommendation regarding water injection at the Beta ridge based on economic analysis.

Eltvik, Petter 18.1.11 13.28
Deleted: stablize

Challenge 5. Rimfaks Cook – Statoil advisor: Kristian Tveiterå

Rimfaks Cook is a small reservoir close to the Gullfaks Field. The estimated oil in place is 1,9 MSm3 with 0,9 GSm3 associated gas. However, the reservoir has not yet been developed.

The task in hand is to evaluate the economical feasibility of the Rimfaks Cook reservoir:

1. Find out how the reservoir fits to the area strategy regarding available infrastructure and capacities.
2. Look at the available data and evaluate the uncertainties (static, dynamic and economical).
3. Use a reservoir simulation model to find a suitable production strategy for Rimfaks Cook including number of wells and pressure maintenance
4. Reflect if the area strategy may make use of templates along the Beta ridge, make economic calculations and list main uncertainties (upsides and downsides).

To evaluate well number and placement, production profile and reservoir uncertainties, the group will have well logs, maps and a reservoir simulation model available.

Challenge 6. Determine the inflow along the wellbore for Gulltopp – Statoil advisor: Eli I. Gule

Gulltopp is developed with a long well (10 km) from Gullfaks A platform.

1. Run the Gulltopp model and plot the inflow along the wellbore of well (A-32).
2. Are there any tools available to measure the flow (PLT, tracers, etc.)?
3. Make a recommendation regarding how to resolve the uncertainties of which zone the Gulltopp well is producing from.
4. Make a recommendation (including cost and possible gains) of data gathering in the Gulltopp well.

6. References

1. Reservoir Management Plan for Gullfaks, GF RESU-HF-07 00122. November 2007