Comparative Case Study

The Center for Integrated Operations in the Petroleum Industry (IO Center) at NTNU includes several research programs. Program 2, named "Reservoir management and production optimization" works with development of methods, technology and work processes for real-time reservoir management and real-time production optimization. One of the program's objectives includes establishment of a benchmark data base for research and trial activities.

The first benchmark case was conducted in 2011, the IO Center and SPE organized an applied technology workshop (SPE ATW) where participants to the case study had an opportunity to discuss and share results. A unique feature of this workshop was to provide the opportunity for sharing best practices in closed loop reservoir management using proven and high quality real production and seismic data. The data used was from E- Segment of the Norne field.

Currently we are announcing the second benchmark case that will utilize Norne fullfield data; this means more data and more working time will be provided. The exercise and the data will be realized in June 2012 and then a similar workshop will be in June 2013. Participants to the case study will be given an opportunity to present and discuss their results.

Provided data

Basically the data supplied includes production data and seismic data. Participants are asked to utilize both provided data; the following are details on the data.

- Reservoir simulation model of full field in Eclipse format, which includes reservoir geometries, PVT fluid properties and relative permeabilities and capillary pressures,
- Wells including logs, check shots, cores, picks, positions, time-depth and header.
- The reservoir has been producing since 1997, oil rate, water rate, gas rate are available for each well and pressure data like bottom hole pressures and well head pressures are also recorded for some wells until 2006.
- Production data for each well to 2006 are given for history matching purpose,
- 4D seismic data in 2001 as base case and three monitors in 2003, 2004 and 2006 - (full stack 4D seismic data)
- Interpreted top reservoir horizon,
- Interpreted faults,
- Well paths for all wells,
- Two velocity cube for conversions, both time and depth. The velocity model is also available.
- Reports and useful information

Description of Exercise


History Match

Forecasting with Optimal EOR/IOR strategy
The participants should work in following workflow:

1. Download the Eclipse Norne model and import it into their reservoir simulator. The production history for 1997-2006, reports and all required data are given in our website http://www.ipt.ntnu.no/~norne/Full-norne/

2. Participants history match the model until the end of 2006 and predict the production (oil, water and gas rates) performance until end of 2016

3. Using the history matched results from above, come up with an **optimal production strategy** for the remaining recoverable resources for the future period. Participants may suggest techniques to enhance recovery, since significant amount of the recoverable reserves are already produced by the end of October 2006.

4. The format for the production strategy contains
   
<table>
<thead>
<tr>
<th>DATE</th>
<th>BHP or Q</th>
<th>WELL ID &amp; Perforation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(bar)</td>
<td>(Sm³/day)</td>
</tr>
</tbody>
</table>

5. The following constraints apply to the strategy:
   
   1. For each injector well max. FBHP = 450 Bar
   2. For each producer well min. FBHP = 150 Bar
   3. For each injector well the max. water rate = 12000 Sm³/day
   4. For each producer well the max. liquid rate = 6000 Sm³/day
   5. Maximum water-cut = 95%
   6. Two wells at max. can be sidetracked to increase recovery

6. The following economic parameters can be used:
   
   - Oil price 75 US$ per bbl
   - Discount rate 10% reference time is January 2005
   - Cost of water handling/injection  6 US$ per bbl
   - Cost of gas injection 1.2 US$ per Mscf (M = 1000)
   - Cost of a new sidetracked well  65 Million US$

   Participants may also assume their own parameters when it comes to other EOR methods eg. Surfactants, Polymers, Low salinity injection etc.

7. Discuss and compare results of their achieved recovery factor.