Drilling program

In the following, we will examine a geological profile which has certain similarities with what has been seen at “Festningen”. Based on a given pore/frac pressure prognosis we will try to develop a casing program and highlight important issues that one has to be aware of during drilling of the different well sections and which drilling problems that may occur. The purpose of the exercise is to give an introductory understanding of the process of constructing a well. In an operator company, the major planning document prior to drilling a well is the drilling program.

The case

A subsea vertical exploration will be drilled in order to investigate if there is an oil reservoir in the limestone/dolomite formation seen at the bottom of the geological profile. The water depth is 225 meters (250 meters measured from RKB). A pore pressure prognosis is given below. This is only an estimate of what is expected since this is an exploration well. The reservoir temperature is expected to be around 170 C. One suspects that there is shallow gas present and some boulders are expected at shallow depths. In some of the shale layers (e.g. in the upper part of Trias) reactive shale can occur. A layer of fractured shale is suspected at around 2700 m.
The following hole and casing sizes is planned for the well.

<table>
<thead>
<tr>
<th>Hole section</th>
<th>Casing size</th>
<th>Setting depth from RKB</th>
<th>Mudweight (s.g.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>36”</td>
<td>30”</td>
<td>?</td>
<td>?</td>
</tr>
<tr>
<td>26”</td>
<td>18 5/8”</td>
<td>?</td>
<td>?</td>
</tr>
<tr>
<td>Run BOP</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>17 ½”</td>
<td>13 3/8”</td>
<td>?</td>
<td>?</td>
</tr>
<tr>
<td>12 ¼”</td>
<td>9 5/8”</td>
<td>?</td>
<td>?</td>
</tr>
<tr>
<td>8 ½”</td>
<td>7” liner</td>
<td>?</td>
<td>?</td>
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</tbody>
</table>

**Questions to be answered**

**Type of well and choice of an appropriate rig.**

1) Why can this well be classified as an HPHT well (high pressure and high temperature well) and what is special with this type of wells?

2) What type of rig would you choose to perform the drilling operation?

**Preplanning/Casing design.**

Casing design and choice of appropriate mudweight for the different hole sections is very important part of the well design process. This often involves computer models and advanced planning. However it is possible to make some simple estimates in advance.

3) Try to find out where you will position the different casing shoes and give some arguments for the choices you make.

4) Which mudweights would you choose for the different hole sections and what determines which mudweights we can use?

**Top hole sections (36” and 26”)**

5) What operational problems/challenges can occur during drilling of the upper sections and what can be done to prevent/reduce these (tools and procedures)?

6) What can you say about cementing of the two upper sections?

**Running Riser and BOP**

The blowout preventor (BOP) is run on the riser. The riser connects the BOP and the rig. From this point we have well control and mud returns are taken on the rig.

7) Consult NORSOKD10 and explain which barriers we have in a drilling operation and explain the main difference between the annular preventer and the other rams (pipe, shear).
Drilling the 17 ½” section

Stuck pipe is known to be a severe event that can be quite expensive and in worst case a fishing operation or a sidetrack can be the final results.

8) Give an overview of different effects that can lead to a stuck pipe incident and what can be done to prevent this? (also use information given in the case description)

9) Discuss which bits you will use in the different hole sections (roller cone vs PDC) and give some advantages/disadvantages associated with each type.

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Drilling the 12 1/4” and the 8 ½” reservoir section

10) The upper sections are usually drilled with water or a waterbased mud system (WBM). It is common to switch to an oil based mud (OBM) in the lower sections. Discuss some advantages/disadvantages with using OBM in this HPHT well.

11) An unintended inflow of gas during drilling is called a kick. If this kick is not brought under control a blowout can be the final disastrous results.


During drilling of the 8 ½” section at around 4300 meters a kick is taken. What can be the reasons for taking a kick and describe briefly the following operational steps.

12) Is there any potential for lost circulation in the reservoir section?
Production wells
The exploration well revealed that there was oil in the reservoir. After some appraisal wells have been drilled, it is time to start drilling production wells.

13) Discuss what well profile you would choose to optimise the production and which challenges you foresee with respect to directional well control taken into account the geological information given initially.

14) What downhole drilling equipment will you use to drill the directional wells?

Presentation
Two groups will be asked to give a powerpoint presentation of 4 minutes each of the main findings in the exercise.
You must bring with you pencils, notebooks & calculator

Responsible teacher
Kjell Kåre Fjelde