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Through-Tubing Rotary Drilling From Njord Floating Platform

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Abstract

The densely faulted Njord reservoir in the Norwegian North Sea is a very complex reservoir. The field is developed from a semi-submersible platform with fifteen subsea-completed wells drilled in a pre-drilling campaign in 1996-97 and two major platform drilling campaigns, one in 1997-2000 and the other in 2002-03. Drilling of two conventional sidetracked oil producers in the last campaign was challenging and costly. As the field matures, the need for a cheaper way of drilling sparsely located smaller undrained compartments became the essence. This led to initiate an ambitious campaign called the LIFT (Low Cost Infill Targets) for identifying and drilling those targets using a cheaper drilling technique called the Through-Tubing Rotary Drilling (TTRD).

TTRD is a hugely demanding task specially, from a floating platform as any economic rationale will be lost if completion accessories and well integrity are compromised through TTRD. To the best of our knowledge, no TTRD operations have previously been executed from a floater. The severity of depletion, especially with depletion and re-pressurization (Huff'n Puff) of parts of the reservoir provides significant technical test and challenge for TTRD on Njord. The relative movement of the floater also presents extra operational challenges, which requires accurate measures to prevent damage to the Tubing Hanger Plug, X-mas Tree, Subsurface Safety Valve and existing completion string. Issues related to Bottom Hole Assembly design to meet drilling and production needs, mud rheology, ECD management, rock mechanics, completion technique, etc. are critically analyzed and risk-reducing/eliminating measures are put in place through extensive research and development for each of the prospective targets.

This paper is intended to give a comprehensive description on the technological challenges of the TTRD technology from a floating platform, research and development activities to qualify the technology on Njord, selection of drilling targets and the drilling experiences from the TTRD wells on Njord.

Introduction

The Njord Field is located in blocks 6407/7 & 10 in the Haltenbanken area of the Norwegian Continental Shelf approximately 130 km northwest of the operations base in Kristiansund (Fig. 1). The field was discovered in late 1985 and went on production on 30 September 1997. Considering deep water (330 m) and limited area distribution of the reserves (6 km in diameter), the field was developed by a semi-submersible platform with production, drilling and living quarters (PDQ) located directly above the subsea completed wells. The subsea completed wells are connected to the platform via flexible risers. The produced oil is stored in a floating storage and offloading unit 2.5 km away from the production platform (Fig. 2).

The commercial reservoir comprises the Lower Jurassic Tilje and Middle Jurassic Ile Formations in the three main areas in block 6407/7, namely, the East Flank, and the Central- and Northern Areas (Fig. 3). However, the Tilje Formations constitute the main reservoirs with 89% of the total in-place oil volumes. The current in-place oil estimate for the Tilje reservoirs is 108.4 MSm3. A total of 17.9 MSm^3 of oil has been produced by January 2005, which constitutes an overall oil recovery factor of only 16.5% for this formation. The reasons for this kind of low recovery factor are mainly two folded: (1) depletion drive is the preferred production mechanism for the Central- and the Northern Areas, and (2) the reservoir is heavily faulted leaving some of the fault compartments undepleted. Due to this low recovery factor, the need for improving the overall recovery factor is paramount.

Infill drilling is one of the most important improved recovery methods on Njord[1]. Different types of wells, e.g., slanted (deviated), horizontal, U-shaped, S-shaped, W-shaped and multi-lateral wells have been drilled to manage the uncertainty and complexity of the geological structures, to maintain drilling safety, to reduce drilling cost and to improve well productivity[2,3]. The drilling of two conventional sidetracked wells in the drilling campaign in 2002-03 was challenging and costly. Worse than expected drilling and production experiences resulted in a postponement of the drilling campaign and to review the infill drilling activities. As the field matures, the drive for a cheaper way of drilling sparsely located relatively smaller undrained pockets became the essence. This led to initiate a new ambitious campaign called the LIFT (Low cost Infill Targets) for identifying and