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Overcoming Challenges during the Development and Installation of Intelligent Completion Systems in SRI Wells

Paul Joseph, SPE, Walter Going, SPE, and Frank Eriksen, Baker Hughes Inc., and Lars Vinje, SPE, and Helge Berland, StatoilHydro

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Abstract

In this age of multi-zone and multilateral wells, existing technologies are always challenged to achieve desired results. In the case of Statoil Skinfaks/Rimfaks (SRI) wells, capabilities of intelligent completion systems were stretched to the limit. Some of the challenges included depth, system optimization, feedback monitoring, subsea logic, placement of downhole hydraulic logic switches, hydraulic timing, cross flow design due to limited control lines, development of an auxiliary logic switch, etc. Operational requirements also pushed downhole tools like the flow control valves and logic switches in a novel and previously untried configuration. System operation logic mandated the design of a very complex hydraulic circuit.

Cross flow design with limited control lines proved to be a significant challenge. Each of the wells had three zones to be controlled. The existing subsea trees allowed only three hydraulic control lines. Three balanced piston flow control valves normally require at least four control lines to be operated. A new system was to be developed to be able to control all three balanced piston valves with only three hydraulic control lines.

This paper will present how a combination of analytical modeling, simulation and laboratory testing was used to overcome these and other design challenges during the system development phase. This novel methodology will aid the optimization and reduction in design cycle time of future intelligent completion systems. Four wells in the Statoil Skinfaks/Rimfaks Improved Oil Recovery Project were completed with intelligent systems in 2007. Thorough planning and execution yielded higher operational efficiency which resulted in job completion ahead of schedule. The installation phase will be discussed in the paper with special emphasis on pre-job planning, operational procedures, post-job results and lessons learned.

Introduction

The Skinfaks/Rimfaks Improved Oil Recovery wells are located in the Gullfaks oil and gas field. Four wells in the field were completed with intelligent systems. Each well had three zones and was approximately 4,900 meters deep. Systems designed to operate each well included adjustable flow control choking valves, hydraulic logic switches to address these valves and thousands of meters of control line for communication between the different components. Maintaining system reliability was important while designing the complex hydraulic circuit to operate the system. In order to overcome design challenges, a combination of analysis and laboratory testing was performed.

Successful installation of any completion system requires systematic planning and close coordination between equipment suppliers, especially since they are located in different parts of the world. Periodic meetings facilitated proper communication between the operator and service companies. The objective was to minimize non-productive time during installation.

System Design

Completion design objectives for the wells included the installation of three surface controlled adjustable choking valves. Normally three hydraulically operated valves would require the installation of four control lines extending from the Christmas tree to the valves. The conventional control scheme dedicates one control line per valve to open each valve and a single shared control line used to close all of the valves. However, the available subsea tree and hanger provided only three available hydraulic communication paths. To accommodate the situation of limited number of penetrations, an alternate control method is available using a single control line to the valve plus an auxiliary switching valve known as the Single Line Switch (SLS).