



OTC 19130

Oriented Perforating as a Sand Prevention Measure — Case Studies from a Decade of Field Experience Validating the Method Offshore Norway

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This paper was prepared for presentation at the 2008 Offshore Technology Conference held in Houston, Texas, U.S.A., 5–8 May 2008.

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Abstract

Oriented perforation is a technique that has been used by Statoil on many fields on the Norwegian Continental Shelf (NCS) during the last decade. By targeting perforations in the most stable direction with respect to the in-situ stress field, one achieves perforation tunnels with optimal “structural” strength for the inherent material strength of the formation rock. For high angle wells in normal faulting environments, this equates to shooting in (or near) the vertical plane through the well path.

Prior to 2000 the tool design for passive orientation was generally inadequate and misalignment of perforations was a distinct possibility. However, collaboration between operators and service companies has led to significant improvements in orientation systems during the last years. Several suppliers now offer orientated TCP systems that are qualified for use in StatoilHydro. Some of these include devices for accurately measuring orientation during perforating.

The operator has chosen oriented perforating as a sand prevention measure in many NCS assets including platform and subsea developments, mature fields and HPHT reservoirs. In many cases the operator believes that oriented perforating is a preferred alternative to mechanical sand control measures. This is discussed in the paper together with the operators operational and production experiences from these applications.

Several years experience confirms that good orientation accuracy can be achieved and designed for. Oriented TCP service has shown a good track record even in well sections with relatively high dogleg or low orientation. Despite the fact that oriented perforating is primarily applied in wells with deviations over 60°, the operator has some sub 50° applications where good orientation was also confirmed. A large body of production experience from several fields confirms that oriented perforating can be a good sand prevention measure in suitable fields. Experience in fields with over 350 bar depletion is presented. The operator suggests that the field data is an excellent confirmation of its sand prediction models and, more generally, of the in-situ stress conditions prevalent on the NCS. Furthermore, it is considered that the success of oriented perforations is an indication of a normal faulting pattern on the NCS. This is in contrast to what has been published by other parties on the NCS.

Introduction

Despite a very good success rate with mechanical sand control, a guiding strategy in Statoil has been to avoid mechanical sand control whenever possible. This is due in part to cost and logistical issues but also to the plugging and productivity decline potential inherent in sand control completions. This is especially true in poorly sorted formations with significant fine fractions and for formations where downhole scale may form upon water breakthrough (ref 1–10).

Oriented perforation is a technique that has been used by the operator on many fields on the NCS during the last decade. By targeting perforations in the most stable direction with respect to the in-situ stress field, one achieves perforation tunnels with optimal “structural” strength for the inherent material strength of the formation rock. For high angle wells in normal faulting environments, this equates to shooting in (or near) the vertical plane through the well path.

Several orientation systems exist in the industry. For TCP applications the orientation is achieved by passive, gravity based systems. Significant improvements in designs have occurred over the last 6–8 years in order to improve orientation accuracy (ref 11–14).

When perforating long horizontal sections, deployment of the perforation guns on drillpipe is often preferred. The well is then kept in overbalance until the completion is installed. In addition to general guidelines, the operator has performed