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Medium Radius Horizontal Sidetracks Reduce Time, Cost and Risks in HT Ghawar Field Wells

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Abstract

Saudi Aramco's first medium radius horizontal sidetrack gas well, Haradh-AX1, was drilled and completed in June, 2008 in a record time of 48.7 days with 4,989 ft of reservoir contact and a 33% reduction in overall cost.

The previous, Khuff-C Horizontal sidetracks which included the same operations; de-completion, sidetracking and re-completion, averaged 83 days with 3,441 ft of sidetracked lateral across the Khuff-C.

Directional drilling in the medium radius lateral after building at 12°/100 ft to a sail inclination of 88° was characterized by better bit performance, lower torque and drag, improved wellbore stability and steerability.

In the previously employed long radius horizontal sidetrack design, extensive milling operations were required to gain access to the 8-3/8" open hole to sidetrack. The 8-3/8" long radius build section would then be drilled from the Base Jilh Dolomite, across the troublesome and sometimes abnormally pressured Lower Jilh and Sudair Shale formations to the top of the Khuff-C where a new 7" liner would be run and cemented. The 5-7/8" lateral would then be drilled across the Khuff-C and an open-hole completion run.

In the medium radius design, the sidetrack (ST) could be made deeper, in the same pressure regime, by cutting a ST window in the existing 7" liner 450 ft true vertical depth (tvd) above the Khuff-C target reservoir, kicking off and drilling 5-7/8" hole across the Khuff-C to total depth (TD).

This paper further details the time and cost savings possible from the application of proven medium radius drilling technology from Saudi Aramco's Arab-D Horizontal Oil wells produced from 6,500 ft tvd to the

deep gas wells produced from the Khuff formation at 12,000 ft tvd, a new drilling environment.

More medium radius horizontal sidetracks are planned and a similar medium radius Khuff-B Horizontal ST, ANDR-AX1, which built at 32°/100 ft, was just successfully completed at 14,819 ft with a 2,400 ft horizontal section.

Introduction

Previously, a total of nine horizontal re-entry/sidetracks were performed on existing poor to non-producing gas wells in the Ghawar field of Saudi Arabia owned and operated by Saudi Aramco. The general procedure was to mill out the 7" liner overlap (500 ft -1100 ft) to around 150 ft below the 9-5/8" shoe.

The milling was extremely tedious and time consuming because of milling related problems such as the formation of "bird's nests" (packing off of swarf in the milling annulus), stuck pipe, inconsistent mill performance and difficulty maintaining milling fluid low-end rheology.

A cement sidetrack plug would then be set in the 8-3/8" open hole, after which the sidetrack would be kicked-off with a long radius build trajectory (typically 3 to 7°/100 ft) to the top of the Khuff-C formation and a new 7" liner was run and cemented in place.

Once the usually higher pressured by as much as 2,400 psi, Khuff-A & Khuff-B formations are cased off, the 5-7/8 in. section of the long radius trajectory would continue building inclination to about 90° across the target producing zone; the Khuff-C; using the minimum required mud weight to drill to TD.

An alternate approach was to set a whipstock in the 9-5/8". casing above the 7" liner top, cut an 8-3/8" window in the