



SPE 115525

Field Trial of a New Non-Damaging Degradable Fiber-Diverting Agent Achieved Full Zonal Coverage during Acid Fracturing in a Deep Gas Producer in Saudi Arabia

J. Ricardo Solares, SPE, J.J. Duenas, SPE, Moataz Al-Harbi, SPE, Abdulaziz Al-Sagr, SPE, Saudi Aramco, Venkateshwaran Ramanathan, SPE, and Ryan Hellman, SPE, Schlumberger

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This paper was prepared for presentation at the 2008 SPE Annual Technical Conference and Exhibition held in Denver, Colorado, USA, 21–24 September 2008.

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Abstract

Acid fracturing has been an integral part of Aramco's gas development strategy for the vertical wells in the Khuff carbonates over the last several years. The Khuff formation is a deep gas carbonate reservoir that is ideally suited for acid fracturing. During acid fracturing, the wormholes created by the reaction, results in excessive fluid loss. Controlling fluid loss is key to optimize acid fracturing treatments by creating longer and wider fractures. Diesel emulsified acid for deeper penetration and in-situ gelled acid, a polymer-based system, are used to control excessive leak-off at different stages of the treatment along with the alternating stages of polymer pad.

These treatments in the vertical wells target several reservoir sub-layers with varying degrees of porosity and permeability contrast. These layers are often divided by anhydrite or dolomitic streaks that make vertical communication within the reservoir challenging. Hence acid fracturing ends up stimulating the highest reservoir quality zones with minimal contribution from the other zones in many cases.

Field trials involving the use of a new degradable fiber technology designed to achieve effective acid diversion during acid fracturing was recently implemented. The trials were conducted in a matrix acid and in an acid fracturing treatments, which were designed and pumped with alternating stages of acid and fiber-laden polymer based pad fluid. The significant viscosity increase achieved in the pad by the addition of fibers and its particulate bridging mechanism would plug off the just stimulated zones effectively, thus diverting the new stage of acid into the non-stimulated porous zones. These fibers degrade and hydrolyze with temperature and time thus leaving the reservoir undamaged.

This paper discusses the planning and design processes leading to the successful implementation of the technology, the experience during the stimulation treatment execution and the excellent post-stimulation results. A production logs was run in the acid fractured well to ascertain the effectiveness of the technology. The results are discussed and compared in the paper with those from offset conventionally acid fractured wells, and the lessons learned throughout the pilot are also shared.

Introduction

Acid fracturing in vertical producers has been used by Saudi Aramco with highly successful results to develop its tight, high pressure/temperature carbonate reservoirs since the beginning of the gas development program. More than 200 fracturing treatments have been implemented over the last 8 years, and a high level of treatment optimization steps and methodologies refinement are continuously implemented thanks to a vast amount of data collected and lessons learned throughout the stimulation campaign. Although, the reservoir development strategy has switched from mostly vertical producers at the beginning of the gas development program to mostly horizontal producers in recent years, a significant number of vertical producers are planned over the next five years and the vast majority of these will require acid stimulation to achieve their maximum potential. The main stimulation