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Successful Multistage Horizontal Well Fracturing In the Deep Gas Reservoirs of Saudi Arabia: Field Testing of a Promising Innovative New Completion Technology

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Abstract

One of the key strategies in Saudi Aramco's optimum gas development project is drilling single and multilateral wells to achieve maximum reservoir contact to maximize well productivity. This strategy has proven very successful over the past few years as the majority of the horizontal gas producers have yielded excellent results, with open-hole completions in particular. Consequently, most of the planned future wells will be drilled as open-hole horizontal completions.

Nonetheless, due to the highly complex nature of the Khuff carbonate reservoir some wells have experienced complications during the drilling phase and encountered unexpected reservoir challenges which has kept them from achieving their production targets. These wells require stimulation to regain their productivity, but the available choices to achieve effective stimulation in horizontal open hole completions have traditionally been limited at best. Previous stimulation attempts with coiled tubing have yielded modest improvements mainly due to difficulty in accessing the long, deep and high pressure/temperature zones requiring treatment. Bullhead treatments at high injection rates have also yielded similar modest well productivity enhancements, because of the inability to achieve effective diversion. Consequently, Saudi Aramco field tested an innovative new completion technology that provided the ability to selectively fracture stimulate multiple zones along the horizontal section. Field trials have yielded excellent and highly promising results, which compared favorably with the performance of non-stimulated offset wells.

It is well-known in the industry that fracture stimulating horizontal open-hole completions with conventional methods is a challenging endeavor, and that often times results are disappointing. Nevertheless, the completion technology tested by Saudi Aramco proved capable of overcoming most of the challenges associated with horizontal fracturing, and effective stimulation of the long horizontal section was achieved. Through this technology multiple mechanical isolation points are created in the wellbore using specially designed multiple open-hole packers, and then selected zones of varying lengths can be individually treated in accordance with reservoir characteristics and production targets.

This paper details the planning and design processes leading to the implementation of the first field trial, experience and lessons learned during deployment of the completion and implementation of the stimulation treatment, and the post stimulation results. Suggested optimization steps from this successful experience are discussed as a way to further enhance the benefits from the technology in future applications.

Introduction

A field trial to hydraulically fracture a long horizontal well was initiated by Saudi Aramco to enhance the maximum reservoir contact concept and maximize well productivity. One of the main motivators for the field trial was that drilling damage was suspected in a number of newly drilled wells, and because of the significant limitations in performing effective and successful horizontal well stimulation techniques it was necessary to change the paradigm and implement new approaches to be able to meet all production targets. Another motivator to proceed with a field trial was to compare the performance of unstimulated dual lateral horizontal wells to that of stimulated single laterals, and ascertain the feasibility of replacing a dual lateral well with a hydraulically fractured single lateral when merited. Saudi Aramco has significant expertise in hydraulic fracturing stimulation techniques as the majority of the vertical wells in the Khuff carbonate formation have been acid