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New Carrier Method for Propellants Offers Flexibility, Simplicity, and Performance

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Abstract

Propellant-based well stimulation is an accepted technology in the oil industry; a number of papers have been published regarding its advantages and advancements (Folse et al. 2001; Gilliat et al. 1999; Yang et al. 1992). The additions of propellant stimulation modeling software and high-speed pressure recorders have greatly assisted in the development and maturing of the technology (Schatz et al. 1999).

The most commonly used propellant for near wellbore stimulation is the propellant sleeve. Propellant sleeve is simply a hollow tube of propellant that is positioned outside of a standard perforating gun and held into place by retaining rings. The detonation of the perforating charges ignites the propellant. The internal ballistic train of the perforating gun is not affected by the propellant because of the sleeve's external placement. This system is both reliable and effective.

A second and less frequently used technique places the propellant inside a vented hollow steel carrier, allowing propellant stimulation without the need of introducing new perforations. Unlike the propellant sleeve system, this system uses detonating cord to ignite the propellant. This method has the ability to stimulate virtually an unlimited amount of borehole by simply interconnecting the vented propellant carriers. However, the ballistic train is exposed to wellbore fluids and pressures. Therefore, when deploying longer intervals (greater than 7 m), the propellant system must be able to reliably continue the ballistics train between interconnected propellant carriers. In the past, the wet-connect system used was unreliable and limited the system to low wellbore pressure applications. Consequently, this method has struggled to gain acceptance primarily due to a lack of a reliable ignition system combined with limited stimulation pressure data.

This paper discusses a new propellant stimulation system that addresses reliability issues that have plagued propellant stimulation systems in the past. It also offers case studies that demonstrate the effectiveness of the new system, performance of the optimized propellant formula as well as the value created from the system's performance and flexibility.

Introduction

It is widely accepted that the processes involved in drilling, completing, and producing / injecting a well have potential to create a zone of reduced effective permeability surrounding the wellbore (Klotz et al. 1974). This is commonly referred to as the damaged zone (Tariq 1987). There are multiple remediation processes available today to re-establish a conductive path through the damage zone to the unaltered reservoir rock. Using pressure generated by the combustion of propellants to initiate and extend short fractures from the wellbore has proved to be a cost-efficient and convenient method of near-wellbore stimulation (Wieland et al. 2006; Schatz et al. 1989).

A selection of propellant tools is available today. The potassium perchlorate propellant sleeve is probably the most widely accepted product. This system consists of a perforating gun with an external sleeve of propellant. When conveyed on tubing or wireline to the correct depth, the gun is fired. The well is both perforated and stimulated in one operation. There are multiple other systems consisting of a protective (vented) carrier, a propellant tube, and a separate ignition system – typically utilizing detonating cord. This is a single trip-operation process used to stimulate either perforated or open-hole intervals. Some systems incorporate conventional interconnect tandem subs allowing multiple propellant carriers to be assembled to stimulate very long intervals. Unlike the propellant sleeve assembly, which has been popularized by its ease of use, reliability, and its dual function, the carrier conveyed system has only gained limited industry acceptance due to the inconsistent ignition of propellant.