



SPE 114885

Shallow Penetration Particle-Gel System for Water and Gas Shutoff Applications

Julio Vasquez, Larry Eoff, and Dwyann Dalrymple, Halliburton, and Jip van Eijden, Shell International E&P

Copyright 2008, Society of Petroleum Engineers

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

This paper was selected for presentation by an SPE program committee following review of information contained in an abstract submitted by the author(s). Contents of the paper have not been reviewed by the Society of Petroleum Engineers and are subject to correction by the author(s). The material does not necessarily reflect any position of the Society of Petroleum Engineers, its officers, or members. Electronic reproduction, distribution, or storage of any part of this paper without the written consent of the Society of Petroleum Engineers is prohibited. Permission to reproduce in print is restricted to an abstract of not more than 300 words; illustrations may not be copied. The abstract must contain conspicuous acknowledgment of SPE copyright.

Abstract

This paper presents the development of a new system for water and gas shutoff operations. This system combines a conformance sealant (based on an organically crosslinked polymer) with non-cement particulates. The particulates provide leakoff control, which leads to shallow matrix penetration of the sealant. This filtrate from the leakoff is thermally activated. After exposure to the bottomhole temperature of the well, it forms a three-dimensional gel structure that effectively seals off the targeted interval. This system can be considered an alternative to standard cement squeeze operations, casing leak repairs, sealing of thief zones, and perhaps many other wellbore operations.

The system can be bullheaded into the well allowing for easy placement and calculation of treatment volume. The limited and controlled leakoff into the matrix during the squeeze results in a controlled depth of invasion. Selective perforation of the oil zones re-establishes the desired hydrocarbon production from the targeted interval. The system can be easily washed out of the wellbore, as compared to cement, which must be drilled out. The temperature range of the particle-gel system is 70 to 350°F (21 to 177°C). To date, more than 54 jobs have been performed with this system. This paper presents results obtained from laboratory evaluations, the methodology of the job design, and limited case history information.

Introduction

The production of unwanted fluids (either water or gas) is a major problem in fields throughout the world, and controlling water production has been an objective of the oil industry almost since its inception. Water tends to become the dominant fluid produced as hydrocarbon fields mature. Produced water has a major economic impact on the profitability of a field because of disposal costs, environmental issues, and reduced hydrocarbon production. In addition, water production causes other related problems including sand production, scale, and corrosion. Water-production problems can vary from: (1) leaks in casing, production tubing, or packers, (2) flow behind casing, (3) water coning (or water cresting in horizontal wells), and/or (4) direct communication from injector to producer through natural or induced fractures.

Numerous methods are available to combat these problems, with each method having its own advantages and drawbacks. One of the earliest methods was to simply carry out a cement squeeze operation to shut off either an isolated section of a wellbore or an entire wellbore. Cement squeezes have been effective in many cases, but there are drawbacks to the system. One drawback is the need to drill out cement left in the wellbore when an entire interval is to be treated so that the productive zone can be re-perforated. This requires the use of a rig and is costly and time consuming. During this drillout process, cement in perforations can be damaged and the intended seal over the offending zone can be compromised, allowing water or gas to continue to flow into the wellbore.

The other main type of treatment used involves the use of sealants to plug the offending zone. These are materials that can be easily mixed and pumped into the wellbore and into the rock matrix. Following a shut-in period, a chemical reaction transforms the liquid into a gel that effectively plugs the treated zone. Again, these systems have been used effectively for many years, but a drawback is that the offending zone must be isolated from the productive zones. If these sealants are allowed into a productive zone, they will damage hydrocarbon permeability and potentially completely seal the hydrocarbon zone. Thus, it is necessary to use some type of isolation technique, which can be costly and in some cases is not feasible due to the wellbore configuration.

Although unwanted fluid production has been resolved in many cases using various techniques, there are opportunities for improvement. This paper will discuss a technique that uses a sealant with a particulate fluid-loss additive that limits leakoff into the formation. The sealant left in the wellbore is easily removed and the limited leakoff of the sealant allows the re-perforation of hydrocarbon zones.