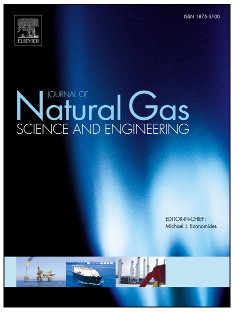
Accepted Manuscript



Gas-lift drilling is potential technique for development of tight oil and gas reservoirs a feasibility study of gas-lift drilling in unconventional tight oil and gas reservoirs

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PII: S1875-5100(16)30893-9

DOI: 10.1016/j.jngse.2016.11.057

Reference: JNGSE 1967

To appear in: *Journal of Natural Gas Science and Engineering*

Received Date: 9 July 2016

Revised Date: 23 November 2016

Accepted Date: 28 November 2016

Please cite this article as: Guo, B., Li, G., Song, J., Li, J., Gas-lift drilling is potential technique for development of tight oil and gas reservoirs a feasibility study of gas-lift drilling in unconventional tight oil and gas reservoirs, *Journal of Natural Gas Science & Engineering* (2017), doi: 10.1016/j.jngse.2016.11.057.

A Feasibility Study of Gas-Lift Drilling in Unconventional Tight Oil and Gas Reservoirs

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Abstract

Development of unconventional tight oil and gas reservoirs is an unsolved problem in the energy industry due to the low productivity of oil and gas wells. The reason is the low permeability of reservoir rocks that are very vulnerable to the contamination of the water in the drilling and fracturing fluids. Although gas-drilling (drilling with gas) has shown to be promising to solve the problem, several problems hinder its application. These problems include formation water influx, wellbore collapse, excessive gas volume requirement, and hole cleaning in horizontal drilling. A new technique called gas-lift drilling has been proposed to solve these problems. A technical assessment of gas-lift drilling was carried out in this study to determine the feasibility of the newly proposed drilling technique. It is found that, compared to conventional (positive circulation) gas drilling, gas-lift drilling can reduce gas injection rate required for hole cleaning by at least 70%. The kick-off pressure for unloading the well depends on water zone pressure and valve setting depth, and can be lowered by reducing valve spacing. The gas injection pressure in gas-lift drilling will be in the same level as in the conventional gas drilling. Mathematical modeling shows that the temperature profiles in the annulus and inside the drill string will be significantly higher than the geo-temperature profile. The gas-lift valve can be designed to open and close automatically depending upon the water-induced pressure inside the drill string. The gas-lift valve design experience gained from gas-lift operations in oil production can be employed in gas-lift drilling. In this paper, it is concluded that gas-lift drilling has the potential to become a viable and feasible technique for development of unconventional tight oil and gas reservoirs with improved performance and reduced cost.

Keywords: Gas-Lift, Drilling, Unconventional, Oil, Gas, Reservoirs

Introduction

Tight reservoirs are generally recognized as oil reservoirs with permeabilities less than 1 mD and gas reservoirs with permeabilities less than 0.01mD. Tight sands and shale oil/gas reservoirs fall in this category. Producing oil and gas from tight reservoirs presents a unique challenge to the energy industry due to the low productivity of oil and gas wells. This is attributed not only to the low permeability of reservoir rocks but also to the fact that they are very vulnerable to the contamination of water from the drilling and fracturing fluids. Li et al.'s (2012) study indicates that the productivity of well can drop easily by 50% in hydraulically fractured wells due to viscous-force-induced fluid filtration, even if the permeability damage due to capillary pressure is neglected. However, the permeability damage due to capillary pressure is still the major factor dominating well productivity (Romero et al., 2003).

While water-free fracturing has been used for improving well productivity in unconventional reservoirs (Guo et al., 2014), gas-drilling (drilling with gas) has shown to be promising to solve the problem (Li et al, 2014). But there are still several problems hindering the applications of gas-drilling. The first problem is the formation water influx during drilling large sections of wet formation intervals (Lyons et al., 2009). Extremely high gas injection rate is required to remove water in large-hole drilling by the gas flow in the annulus, which is in many cases not feasible. This historical problem has become a bottleneck for gas-drilling applications. The second problem is the wellbore collapse induced by wetting of formation rock in the upper-hole sections by the produced formation water. Formation rocks such as shale contain clays and thus absorb water, swell and create hole-wall stresses, resulting in borehole collapse (Lyons et al., 2001). The third problem is the excessive gas volume required for removing drill cuttings in the annulus drilled with drill bits larger than 10-inch diameter (Guo and Ghalambor, 2002), which is extremely costly. The fourth problem is complications in horizontal drilling associated with formation of cuttings dome in the annulus. Typical drilling complications are associated with high-drag and torque of drill string and induced pipe sticking (GRI, 1997).

A new technique called gas-lift drilling has been proposed to solve the problems associated with the conventional gas-drilling. The gas-lift drilling will remove drill cuttings and produced formation water through the inside of the drill string rather than through annulus. The feasibility of gas-lift drilling was investigated in this study on the basis