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A New Solution to Restore Productivity of Gas Wells with Condensate and Water Blocks

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Abstract

During production from gas condensate reservoirs, significant productivity loss occurs after the pressure near the production wells drops below the dew point of the hydrocarbon fluid. Many of these gas reservoirs also have some water accumulation near the wells. This adds significantly to the total liquid blocking.

Experiments were conducted using both outcrop sandstone and reservoir cores to measure the effect of liquid blocking on gas relative permeability. A chemical treatment was developed to reduce the damage caused by condensate and water blocking. The treatment is composed of a fluorinated material delivered in a unique and optimized glycol-alcohol solvent mixture. The chemical treatment alters the wettability of water-wet sandstone to neutral wet and increases the gas relative permeability.

The increase in gas relative permeability was quantified by comparing the gas relative permeabilities before and after treatment. Improvements in the gas relative permeability by a factor of about 2 were observed. The alteration of wettability after the chemical treatment was evaluated by measuring the USBM wettability index of treated reservoir cores. Measurements show a significant amount of the surfactant is adsorbed on the rock surface, which is important for the durability of the treatment.

Many attempts have been made to develop effective chemical treatments to mitigate the damage caused by condensate and/or water blocking with little success until now under realistic reservoir conditions. Using inexpensive, safe and effective solvents was one of the keys to the success of our new approach. Others have mostly tried reactive materials that are subject to complications in downhole applications. We use a non-reactive, nonionic polymeric surfactant that does not have any of these problems and is robust over a wide range of temperature, pressure, permeability and brine salinity.

We have developed a chemical treatment for liquid blocking that shows great potential to increase production from gas condensate wells. Compositional simulations indicate the economics of this treatment process are likely to be very favorable.

Introduction

In gas condensate reservoirs a significant loss in the well productivity is observed when the bottomhole pressure in flowing wells falls below the dew point pressure of the fluid (Afidick *et al*., 1994; Barnum *et al*., 1995; Engineer, 1985; Ayyalasomayajula *et al*., 2005). The reduction in well productivity is caused by the buildup of a condensate bank around the well, which impeded the flow of gas to the well and thus reduces its productivity.

Since the reduction in well productivity is primarily associated with the reduction in gas relative permeability, a great deal of effort has gone into measuring and modeling the relative permeability of gas-condensate fluids. Initially, the studies were done at low pressure and temperature (Ham and Eilerts, 1967). Later studies were done at reservoir conditions with synthetic fluids (Henderson *et al*., 2000; Kumar *et al*., 2006; Kumar, 2006; Ayyalasomayajula *et al*., 2003; Bang *et al*., 2006) as well as with reservoir fluids (Nagarajan *et al*., 2004; Mott *et al*., 2000). Various parameters such as interfacial tension (Henderson *et al*., 2000), high flow rates (Kumar *et al*., 2006; Kumar, 2006; Ayyalasomayajula *et al*., 2003; Bang *et al*., 2006; Nagarajan *et al*., 2004; Mott *et al*., 2000), non-Darcy effects (Kumar *et al*., 2006; Nagarajan *et al*., 2004), fluid composition (Mott *et al*., 2000) and rock (Mott *et al*., 2000) have been investigated.

Several methods have been proposed to restore gas production rates after a decline owing to condensate and/or water blocking. The most common approach to treat damage caused by condensate blocking are either to change the phase behavior of the gas condensate fluid or to reduce the pressure drawdown and maintain pressure above the dew point pressure. Gas