Post-Fracturing Chemical and Mechanical Alterations of Unconventional Shale Reservoirs

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Abstract

This study employs dynamic core flooding experiments by injecting fracturing fluids through artificial fractures in shale core-plugs to investigate the impact of geochemical reactions and geo-mechanical stresses on petrophysical and mechanical properties of shale during and after hydraulic fracturing. Core flooding experiments were conducted at temperatures of 95^{o}C, pore pressure of approximately 2200psi and confining pressure of approximately 4100psi. Effluent sampling was conducted during fluid flow. Sample parameters were measured before the experiment and after the experiment to enable evaluation of changes that occurred due to rock-fluid reactions and mechanical stresses. X-ray fluorescence (XRF), computed tomographic (CT) scanning, scanning electron microscopy (SEM), energy dispersive spectroscopy (EDS), and rebound hardness tests (RBH) were used to assess the rock cores' chemical, mineralogical, and mechanical properties before and after experiment. The results from these tools were subsequently integrated to provide comprehensive understanding of geochemical and mechanical changes that result from interactions between rocks and injected fluids.

Results from experiments show transformation of chemical compositions on fractured faces of the shale that confirms considerable reaction between rock and fluids. Changes in concentrations of elemental species such as Ca, Mg, Na, Fe, K, and Al point to the dissolution and precipitation reactions during core flooding. The dissolution and precipitation of minerals observed in XRF analysis is corroborated by results from CT scanning and SEM/EDS investigations. In the CT scanning, the closure of fractures parallel to the direction of confining pressure indicates the impact of geochemical reactions on fracture closure. SEM/EDS investigations provide conclusive proof of precipitation of calcite and Ca-rich phases on the fracture faces of the shale after core flooding. The disparity in rebound hardness of the samples confirms the dissolution and precipitation of minerals at various positions on the fracture face of the shale. The results obtained in this study

are in agreement with results from static batch reactor experiments conducted at 95^{o}C to assess subsurface geochemical rock-fluid reactions in Caney Shale.

This work gives an insight into rock-fluid reactions along fracture walls in hydraulically fractured reservoirs of the Caney Shale in southern Oklahoma. It highlights the alterations on fracture walls during rock-fluid reactions and the impact of these on petrophysical and mechanical properties of the fracture walls.