Docket #: S18-329

Inhibiting Barite Scale Precipitation in Hydraulic Fracturing

Barite scale formation in hydraulic fracturing systems is a significant problem with regards to production and permanent formation damage. Barite added to drilling mud (20-60 wt.% barite) used in these systems is a significant source of barium and sulfate which is not stable in the presence of 15% hydrochloric acid commonly injected at the beginning of stimulation in unconventional systems. The release of barium and sulfate from drilling mud is deleterious because these dissolved constituents will be transported from areas with high volume/porosity (near bore-hole) to regions with very small volume/porosity (distal fractures, micro-/nano-pores, pore necks, etc.) where it can precipitate as barite further reducing porosity/permeability in extremely low permeability shales. A Stanford researcher developed a chemical formulation that stabilizes barite in the drilling mud preventing the dissolution and transport of barium and sulfate into the fracture/pore network while maintaining similar acidity as 15% hydrochloric acid. To combat scale, a combination of sulfuric acid (~6%) and sodium citrate is injected into the subsurface instead of the 15% hydrochloric acid currently being used. The sulfuric acid stabilizes the barite while the sodium citrate chelates calcium released from the dissolution of calcite in the rocks, inhibiting both barite and gypsum formation in shales. To further combat gypsum formation, mixtures of hydrochloric and sulfuric acid can be used in conjunction with sodium citrate to adjust for rocks with varying calcite and clay concentrations. This formulation modification can be tailored to specific shales that an operator is interested in stimulating. This formulation will significantly aid in mitigating barite scale common in hydraulic fracturing systems which can lead to an increase in the overall production and recovery of natural gas or crude oil in unconventional oil/gas systems.

Applications

- Oil and gas hydraulic fracturing

Advantages

- 800-fold reduction in released barium and sulfate from drilling mud.
    - Stabilizes the barite, eliminating barite scale formation in shale for both low-carbonate/high-clay and high-carbonate/low-clay rocks.
    - Mitigates secondary mineral precipitation of gypsum in low-carbonate/high-clay rocks, and significantly reduces gypsum formation in high-carbonate/low-clay rocks..
- Increases oil and gas production from shale.
- Easily integrates into current drilling practices - does not require industry to alter the weighing agent (barite) added to the drilling mud to prevent well bore blowout at depth.

Patents

- Published Application: 20200048972
- Published Application: 20210332651
- Issued: 11,187,051 (USA)

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