Title: Microfluidic Applications in Frac Chemistry: Development and Evaluation with Reused Produced Water

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Abstract:

Unconventional reservoirs play an important role in the global energy supply nowadays due to recent advancements in hydraulic fracturing. It has been reported that the selection of completion chemicals has a significant impact on oil and gas production due to fluid incompatibility and polymer-induced formation damage. To optimize oil and gas production, flowback efficiency, and fracturing fluid-induced permeability damage, different completion fluid packages were evaluated using microfluidics.

Produced water, the byproduct of oil and gas extraction, is increasingly being utilized in hydraulic fracturing operations as a sustainable alternative to freshwater sources. By recycling and reusing produced water in fracturing processes, oilfields can minimize waste and lower operational costs, ultimately promoting a circular economy within the industry. Additionally, the use of treated produced water can enhance the overall sustainability of oilfield operations by decreasing the environmental footprint and improving water management practices, aligning with the industry's growing emphasis on responsible resource use and environmental stewardship.

Two microfluidics chips were designed to evaluate regain conductivity and flowback efficiency in this work. The regain conductivity chips, representing proppant-packed fractured zones, were designed with two different fracture depths. The flowback chips consist of a high permeability zone and nanoscale channels to simulate fluid characteristics and transport in fractures, matrix, and their interface. Time-lapse microscopic images and videos of the chips were recorded during testing and the oil production was quantified using an automated images analysis platform. Microfluidic experiments were conducted using filtered produced water and oil samples collected from the field.

This study introduces novel selection criteria for the design of completion fluid packages, aiming to optimize oil production in unconventional reservoirs. The pore-scale optical access of microfluidics enables a better understanding of formation damage and oil recovery mechanisms. Additionally, this microfluidic approach offers significant reductions in testing cost and time while providing improved reproducibility compared to traditional testing methods.