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Quantifying sulfate reduction rates of biofilm on shale fracture walls within a microfluidic reactor

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During hydraulic fracturing, preferential flow paths are created to extract hydrocarbons from shale reservoirs, typically with large amounts of produced water. The water is often rich in hydrocarbons and sulfate, providing ideal nutrients for promotion of sulfate reducing bacteria (SRB) growth and biosouring. Bacteria growth may clog fracture pathways and decrease hydrocarbon production, while biosouring represents a pipeline corrosion and human health hazard that can shut down production. In this work, a natural shale sample is shaped to create two inlets that feed into a single 250 μm-wide fracture, all contained within a microfluidic platform. Hydrocarbon fermentation products (i.e., fatty acids) are fed into one inlet, and sulfate into the other; they mix in the fracture and promote biomass growth and sulfate reduction. SRB biofilms on shale fracture walls are quantified using bright-field microscopy and image analyses, and sulfate reduction is quantified using a zinc trap to capture effluent sulfide. A numerical model is developed to interpret the biomass growth results, and to quantify sulfate reduction rates. These rates are compared to those reported in the literature for batch experiments, and recommendations for accurately modeling sulfate reduction in shale fractures are proposed.

Time Block Preference

Time Block A (09:00-12:00 CET)

References

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