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Perchlorate as an alternative to nitrate: exploring a novel souring mitigation approach

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CTR.2.D Scale & Corrosion

Reservoir souring (increase of hydrogen sulfide concentration in produced fluids) has a significant economic impact on the oil industry and poses a health risk for workers as it can cause death by inhalation. Sulfate reduction by microorganisms is the most significant source of hydrogen sulfide production in oil reservoirs. As more reservoirs are flooded with seawater (a great source of sulfate) for secondary oil recovery, understanding the parameters and controls of microbial oil souring becomes vital. Nitrate injections into the reservoirs have been previously used to constrain souring by inhibiting the metabolism of sulfate reducing microorganisms and thus preventing hydrogen sulfide production. Perchlorate has been recently suggested as a new promising souring mitigation agent. Perchlorate, similarly to nitrate/nitrite, has an inhibitory effect on microbial sulfate reduction.

We tested the efficacy of perchlorate in inhibiting sulfide production using field-relevant pure cultures of sulfate reducing bacteria and archaea, as well as enrichment cultures of sulfate-reducing microorganisms from produced water samples (North Sea). As controls we also examined the efficacy of nitrate and nitrite.

Our results suggest that perchlorate delays rather than suppresses the growth and metabolism of the tested sulfate reducing strains. Only in the case of the produced water enrichments, we observed a complete inhibition of growth with a perchlorate concentration of 10 mM. Contrary to perchlorate and nitrate, nitrite appeared to be the most effective souring mitigation agent in our study. Nitrite inhibited growth of all tested strains at concentrations as low as 1 mM.

Using the lab based experimental data we will evaluate the effectiveness of perchlorate compared to nitrate/nitrite in the field scale using a representative numerical model.