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Experimental study of microbial hydrogen consumption rates by Oleidesulfovibrio alaskensis in porous media

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The recovery efficiency of short- and long-term cyclic operations of porous media underground hydrogen storage (UHS) is a key parameter for successful implementation, but anaerobic microbes autochthonous in the storage formation can consume hydrogen and adversely influence hydrogen recoverability and storage efficiency. Here we have experimentally measured hydrogen consumption rates by a model sulphate-reducing bacterium (Oleidesulfovibrio alaskensis G20) in drainage-storage cycles that mimic porous media UHS. Laboratory tests were performed in cylindrical sand pack columns as storage site analogues (inner diameter: 51.4 mm, length: 14.7 mm) with an average porosity of 28% at conditions of 37oC and 1.15 bara. The storage capacity (initial hydrogen saturation in place) of each sand pack was in addition analysed and compared against sterilized benchmarks. We observed an exponential decay in microbial hydrogen consumption between storage cycles: 28 ± 12% hydrogen was lost during the first cycle (with a peak average rate of 1.26 ± 0.12µmol/hr/cm3), compared with 10 ± 5% (second cycle) and 7 ± 3% (third cycle). The cumulative loss across the three cycles amounted to 15 ± 6%, even though nutrient and carbon source concentrations were adequate for full hydrogen consumption in each cycle. The reduced microbial activity after the first storage cycle was explained by the observed increase in brine pH from initial 7.5 to 8.4 ± 0.2 at the end of the last storage cycle. We observed improvement in the average hydrogen in place saturations after the first non-sterile storage cycles. Our experimental data contributes to the understanding of microbial hydrogen loss during UHS and how it can affect the recovery and storage efficiency.

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References

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