Effects of microbiological processes on corrosion in geological H_2 storage – results of laboratory long-term experiments

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To investigate the potential impact of hydrogen storage on geological formations two long-term experiments were performed in corrosion-resistant high pressure vessels under controlled pressure and temperature conditions to study microbial induced corrosion processes. Pristine rock cores from the Ketzin storage site were incubated with synthetic brine and were exposed to a gas mixture including CO_2, N_2, He, and H_2 at 40 bar and 35°C. To stimulate microbial activity, mild carbon steel coupons were inserted while one coupon was covered by a natural biofilm that was formed in the saline fluids of a geothermal plant.

In the experiment with the inserted biofilm, H_2 increased after 62 days significantly ($\Delta H_2 = 20$ %), even after a gas refill. Correspondingly, the CO_2 concentration decreased after 62 days ($\Delta CO_2 = 3.4$ %). However, the H_2 concentration in the vessel with the bright coupon increased only slightly after 55 days ($\Delta H_2 = 9.3$ %). Microorganisms were detected in fluid samples and at the coupons using molecular biological methods. Quantitative PCR proofed a higher abundance of bacteria in the fluid and on the coupon with the biofilm covered coupon. Furthermore, an increase of the abundance of sulfat-reducing bacteria was detected in dependance to the increase of H_2S (170 ppm) in the gas phase. The results suggest that due to CO_2 exposure, corrosion processes occur at the steel coupons which were probably influenced by microorganisms.