Goldschmidt 2024 Abstract
https://doi.org/10.46427/gold2024.24054

Effects of impurities on CO_2 in carbonate rocks – potential effect on storage scenarios

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Storage of carbon in the form of compressed CO_2 in the subsurface represents a potentially viable and cost-effective way to reduce emission of heat-trapping CO_2 to the atmosphere. The chemical composition of the CO_2 stream will depend on the fuel sources and capture methods, and impurities in CO_2 impact corrosion and scaling, temperature and pressure conditions, caprock integrity, biological activity in the subsurface, injectivity, interfacial behaviour, mineral trapping and interactions with the rock surface amongst others. It is particularly important to investigate the effects of highly impure CO_2 sources on injectivity and storage, as the achievable limits of impurities are crucial for practical implementation in the field. The aim of this study is to consider the effects of CO_2 purity on storage in mature Danish chalk oil reservoirs in late stages of production with geological and petrophysical characteristics favourable to CO_2 injection. The effects of major impurities (SO_2, N_2 and O_2) on phase behavior as well as corrosion in pipelines are quite well understood and some studies have addressed the geochemical effects of impurities for shales and sandstone reservoirs. However, the geochemical effects of long-term storage of impurity-containing CO_2 are not well known, particularly for carbonates, including chalk. Injection testing of these impurities in Danish North Sea Chalk cores are conducted in core flood experiments and static experiments combined with chemical analysis of the effluent fluids and chalk surfaces to investigate the alterations caused by impurities. The effect of SO_2, H_2S and NO_2 impurities in CO_2 are tested on reservoir chalk samples in order investigate chalk dissolution caused by reactive impurities. The initial core flood experiments are carried out at the temperature and pressure of the target depleted chalk reservoirs in the Danish North Sea region using the identified most abundant chemically active impurities. These impurities are combined with CO_2 in a high pressure mixing cylinder and compressed to supercritical CO_2 conditions at the chosen reservoir temperature and tested on cleaned reservoir core plugs.