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Gas condensate reservoir characterisation for CO_2 geological storage

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During oil and gas production hydrocarbon recovery efficiency is significantly increased by injecting miscible CO_2 gas in order to displace hydrocarbons towards producing wells. This process of enhanced oil recovery (EOR) might be used for the total CO_2 storage after complete hydrocarbon reservoir depletion. This kind of potential storage sites was selected for detailed studies, including generalised development study to investigate the applicability of CO_2 for storages. The study is focused on compositional modelling to predict the miscibility pressures.

We consider depleted gas condensate field in Kazakhstan as important target for CO_2 storage and EOR. This reservoir being depleted below the dew point leads to retrograde condensate formed in the pore system. CO_2 injection in the depleted gas condensate reservoirs may allow enhanced gas recovery by reservoir pressurisation and liquid re-vaporisation. In addition a number of geological and petrophysical parameters should satisfy storage requirements. Studied carbonate gas condensate and oil field has strong seal, good petrophysical parameters and already proven successful containment CO_2 and sour gas in high pressure and high temperature (HPHT) conditions. The reservoir is isolated Lower Permian and Carboniferous carbonate platform covering an area of about 30 km. The reservoir contains a gas column about 1.5 km thick. Importantly, the strong massive sealing consists of the salt and shale seal. Sour gas that filled in the oil-saturated shale had an active role to form strong sealing. Two-stage hydrocarbon saturation of oil and later gas within the seal frame were accompanied by bitumen precipitation in shales forming a perfect additional seal.

Field hydrocarbon production began three decades ago maintaining a strategy in full replacement of gas in order to maintain pressure of the reservoir above the dew point. This was partially due to the sour nature of the gas with CO_2 content over 5%. Our models and calculations demonstrate that injection of produced and additional gas (CO_2 and sour gases) is economically viable and ecologically safe. Gas injection monitoring using surface injection well head pressures and measured injected volumes demonstrates a highly effective gas injection process. Injection well head pressure response shows no increase, indicating absence of compartmentalization close to the near well bore gas injection region in reservoir. And injector pulse study shows interconnectivity across the injection region highlighting good quality reservoir across the potential CO_2 injection zones. Preliminary CO_2 storage potential was also estimated for this type of geological site.