Comprehensive sensitivity analysis on static and dynamic reservoir parameters impacting near wellbore injectivity during CO_2 sequestration

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Abstract. Carbon capture and storage (CCS) is proved to be effective measure for reducing CO_2 emissions. whilst the world still highly depends on the use of fossil fuel energy, this method is necessary for reaching the world's 1.5 °C goal.

In CCS, CO_2 is hindered from entering the atmosphere by capturing it from sources of emission and storing it in geological formation. Saline aquifers among all possible underground formations are most common targeted ones for CO_2 storage due to their frequent presence, and large storage capacity. However, this storage option suffers from sufficient well injectivity to inject large volumes of CO_2 at acceptable rates through a minimum number of wells.

The injectivity impairment / reinforcement happens through mineral dissolution, fine particle movement, salt precipitation and hydrate formation (known so far). Each of these mechanisms will be more dominant in injectivity alteration at different distance from the injection point depending on reservoir pressure and temperature, formation water salinity, rock mineralogy, and flow rate of CO_2 injection as well as its dryness.

Incorporating all the finding into radial flow near wellbore will help gaining insight into the resultant of injectivity changes over time and distant from injection point. In this study we have chosen Eclipse 300 together with an open-source code to investigate the impact of formation characteristics, CO_2 -Brine-Rock interaction, pressure, temperature as well as injection rate on injectivity alteration. The goal for this work is to provide a workflow which can help predicting injectivity alteration using the existing tools.

Simulation results show that the high homogenous horizontal permeability in combination with vertical flow baffles in the formation (among all other parameters) has positive impact on storage capacity by increasing residual trapping. However, permeability is affected severely by salt precipitation during CO_2 injection. Combined static and dynamic parameter study demonstrate that the injection rate plays a crucial role in size and expansion of CO_2 plume as well as growth rate of dry out zone length, amount of salt precipitation and length of equilibrium region. The higher the injection rate, the quicker activation of the capillary and gravity force which leads to drag more brine to near well-bore resulting in higher volume fraction of salt precipitation. However, low injection rate could result in smaller CO_2 plume, shorter dry out zone and longer equilibrium region in term of distance from injection point.

Keywords: CO_2 storage, simulation, injectivity.