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CO2-EOR and Storage Potentials in Depleted Reservoirs in the Norwegian Continental Shelf (NCS)

Elhans Imanovs (Reservoir Engineer, Trident Energy) was one of three winners of the SPE UK Student Paper Contest in 2019. His paper was promoted for European Qualifier at the Annual Student Energy Congress (ASEC) 2020 in Croatia.

Elhans analysed different Water-Alternating-Gas (WAG) injection methods using carbon dioxide as an injection gas to find an optimal solution for simultaneous carbon dioxide storage and enhanced oil recovery in one the fields in the Norwegian Continental Shelf (NCS). This project was completed as part of his MSc course at ICL in collaboration with Equinor, supervised by Dr Samuel Krevor (ICL) and Ali Mojaddam Zadeh (Equinor ASA).

Two global challenges are an increase in carbon dioxide (CO_2) concentration in the atmosphere, causing global warming, and an increase in energy demand (UNFCCC, 2015; EIA, 2018). Carbon Capture and Storage (CCS) is believed to be a major technology to considerably reduce CO_2 emissions (Budinis et al., 2018). Applying this technology, the anthropogenic CO_2 could be injected into depleted reservoirs and permanently stored in the subsurface. However, standalone CCS projects may not be economically feasible due to CO_2 separation, transportation and storage costs (Pires et al., 2011). On the other hand, one of the most efficient Enhanced Oil Recovery (EOR) methods is carbon dioxide injection (Holm, 1959). Therefore, a combination of CO_2-EOR and storage schemes could offer an opportunity to produce additional oil from depleted reservoirs and permanently store CO_2 in the subsurface in an economically efficient manner.

In this study, a depleted sandstone reservoir located in the Norwegian Continental Shelf (NCS) is used. An innovative development scenario is considered, involving two phases: CO_2 storage phase at the beginning of the project followed by a CO_2-EOR phase. The objective of this paper is to evaluate the effect of different injection methods, including continuous gas injection (CGI), continuous water injection (CWI), Water Alternating Gas (WAG), Tapered WAG (TWAG), Simultaneous Water Above Gas Co-injection (SWGCO), Simultaneous Water and Gas Injection (SWGI) and cyclic SWGI on oil recovery and CO_2 storage potential in the depleted reservoir.

A conceptual 2D high-resolution heterogeneous model with one pair injector-producer is used to investigate the mechanisms taking place in the reservoir during different injection methods. This knowledge is applied in a field scale, realistic 3D compositional reservoir model of a depleted sandstone reservoir in the NCS including ten oil producers and twenty water/gas injectors.

The simulation results demonstrate that innovative development scenario is viable to improve oil recovery and storage capacity in the depleted reservoirs. Different injection scenarios are benchmarked, and cyclic SWGI method is found to be the most efficient scenario in enhancing oil recovery and employing the highest capacity for CO_2 storage, shown in *Figure 1*.

In September 2019, the SPE London Student Section held its Annual Young Professionals/Student paper contest at London South Bank University. Eight papers were presented with students coming from as far afield as Edinburgh, East Kilbride, London and Portsmouth. The judges, from the SPE London Section, chose three winners: Brian Willis (Astrimar Ltd), Keim Nguyen (London South Bank University), and Elhand Imanovs (Imperial College).

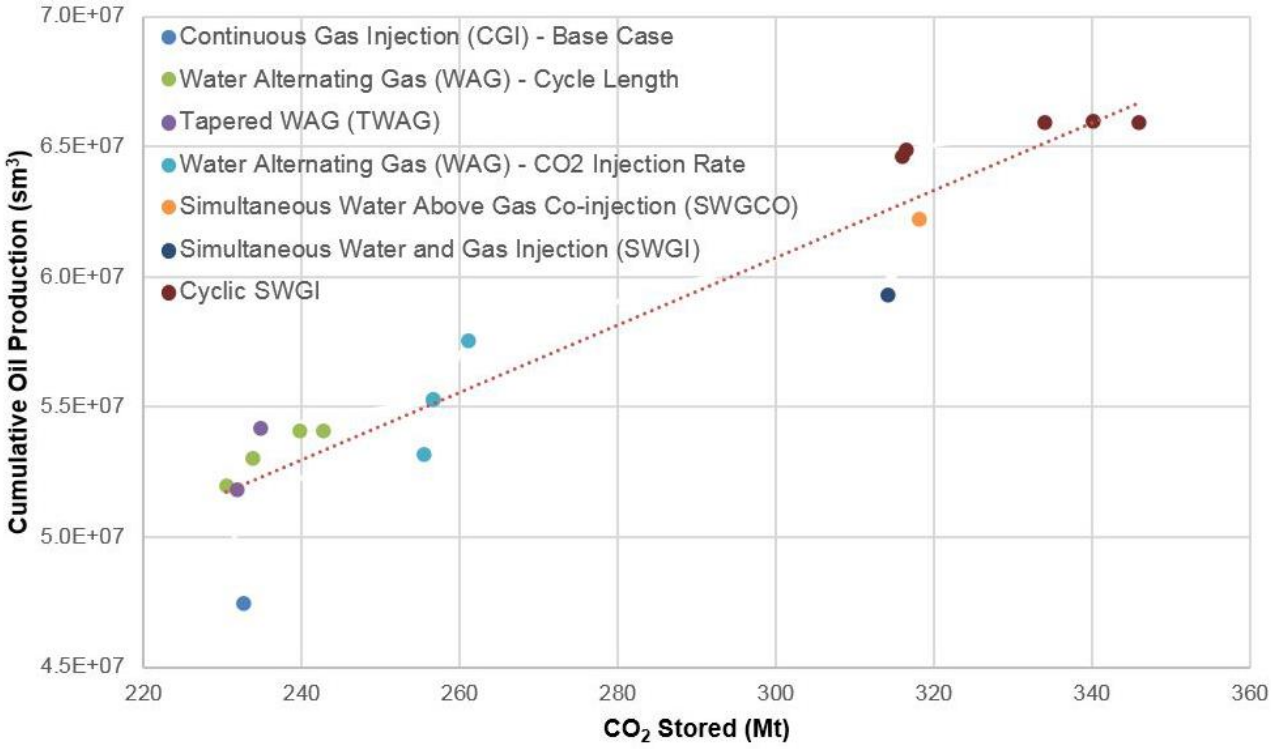

Figure 1 Different injection scenarios