Synergy between Carbon Dioxide Storage and Incremental Oil Recovery

Gang Wang, Eric Mackay, Gillian Pickup and Peter Olden.

Heriot-Watt University, EH14 4AS

Introduction

This study investigates combined strategies for CO_2 storage and incremental oil recovery in a synthetic reservoir/aquifer model. The model was derived from an existing model of two domed structures in the Bunter Formation in the S. North Sea. For this study, it was assumed that one of the domes (Dome A) contained oil but the other dome (Dome B), which was below the oil-water contact, contained only water (brine). The objective was to simulate CO_2 injection into either Dome A or B and study the effect on oil recovery and CO_2 storage. Some sensitivities to reservoir parameters such as injection strategy, injection timing and anisotropy were also investigated.

Methodology

Geological Model + ***Dynamic Parameters***

Two-dome structure of Bunter Sandstone

Fluid properties of Pembina Oil Reservoir

Simulator: GEM/CMG

Research object of this study

References

Holloway, S., Vincent, C., Bentham, M. and Kirk, K. (2006). Top-down and bottom-up estimates of CO_2 storage capacity in the United Kingdom sector of the southern North Sea basin. Environmental Geosciences, 13(2), pp.71-84.

Melzer, L. S. (2012). Carbon dioxide enhanced oil recovery (CO_2 EOR): Factors involved in adding carbon capture, utilization and storage (CCUS) to enhanced oil recovery. Center for Climate and Energy Solutions.

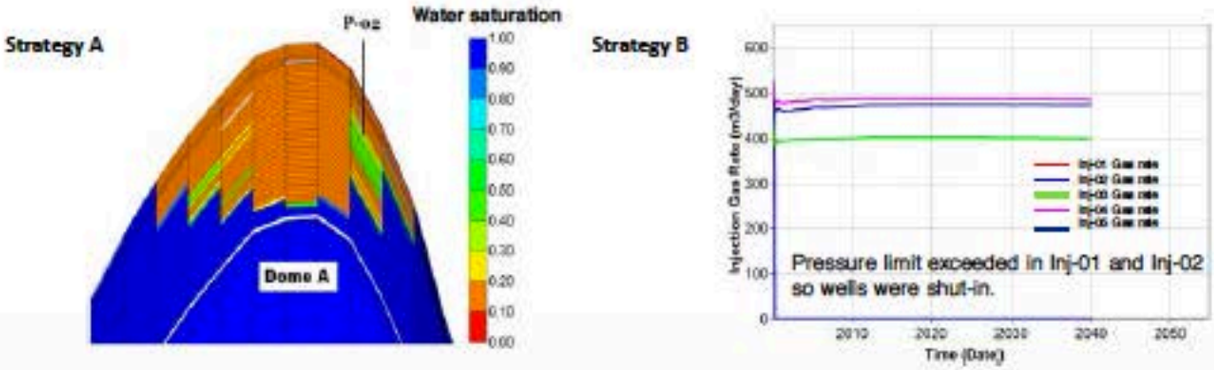
Qi, R., LaForce, T. and Blunt, M. (2008). Design of Carbon Dioxide Storage in Oil Fields. SPE Annual Technical Conference and Exhibition.

Results

Injection Strategy A: 40-year CO_2 injection into Dome A leads to gas breakthrough.

Injection Strategy B: inject CO_2 into Dome B from the start of reservoir depletion, no gas breakthrough into producers, greater recovery efficiency and CO_2 storage.

Lowering Vertical Permeability: side water breakthrough in Strategy A; lower injectivity in Strategy B.



Conclusions

There is a consistent synergy between CO_2 storage and incremental oil recovery efficiency. Specifically the greater the pore volume occupied by CO_2, the greater the displacement of oil. Both injection timing and strategy could have a large influence on the reservoir behaviour.

- The key influencing factor to maximise the recovery efficiency and secure storage is to prevent the early gas or water breakthrough. Recovery efficiency and storage capacity increased with later injection timing.
- The recovery factor and net storage are both greater if the injection is applied into the pure aquifer Dome B compared with injection into the oil zone Dome A.
- The recovery efficiency decreases with vertical permeability in the both cases.
- Vertical permeability has a negligible effect on CO_2 storage, when injection is into Dome A. However, it has a large effect when injecting into Dome B due to the long distance between injectors and producers.

Acknowledgments

I would like to express my sincere gratitude to my supervisors Prof. Mackay, Dr. Pickup and Dr. Olden for the continuous support of my research study, for their patience, motivation, and immense knowledge. My sincere thanks also go to Dr. Chen (BP), who provided an insight for me to study abroad. Last but not least, I would like to thank my family: my parents and my girlfriend for supporting me spiritually throughout the whole master period.