Geophysical Research Abstracts
Vol. 15, EGU2013-6034-1, 2013
EGU General Assembly 2013

A dynamic flow simulation code benchmark study addressing the highly heterogeneous properties of the Stuttgart formation at the Ketzin pilot site

Thomas Kempka (1), Holger Class (2), Uwe-Jens Görke (3), Ben Norden (1), Olaf Kolditz (3,4), Michael Kühn (1), Lena Walter (2), Wenqing Wang (3), and Björn Zehner (3)

(1) Helmholtz Centre Potsdam, GFZ German Research Centre for Geosciences, Telegrafenberg, 14473 Potsdam, Germany, kempka@gfz-potsdam.de, (2) Stuttgart University, Hydromechanics and Modelling of Hydrosystems, 70569 Stuttgart, Germany, (3) Helmholtz Centre for Environmental Research - UFZ, 04318 Leipzig, Germany, (4) Technical University Dresden, Faculty of Forest, Geo and Hydro Science, 01062 Dresden, Germany

CO_2 injection at the Ketzin pilot site located in Eastern Germany (Brandenburg) about 25 km west of Berlin is undertaken since June 2008 with a scheduled total amount of about 70,000 t CO_2 to be injected into the saline aquifer represented by the Stuttgart Formation at a depth of 630 m to 650 m until the end of August 2013. The Stuttgart Formation is of fluvial origin determined by high-permeablity sandstone channels embedded in a floodplain facies of low permeability indicating a highly heterogeneous distribution of reservoir properties as facies distribution, porosity and permeability relevant for dynamic flow simulations.

Following the dynamic modelling activities discussed by Kempka et al. (2010), a revised geological model allowed us to history match CO_2 arrival times in the observation wells and reservoir pressure with a good agreement (Martens et al., 2012). Consequently, the validated reservoir model of the Stuttgart Formation at the Ketzin pilot site enabled us to predict the development of reservoir pressure and the CO_2 plume migration in the storage formation by dynamic flow simulations.

A benchmark study of industrial (ECLIPSE 100 as well as ECLIPSE 300 CO_2STORE and GASWAT) and scientific dynamic flow simulations codes (TOUGH2-MP/ECO$_2$N, OpenGeoSys and DuMuX) was initiated to address and compare the simulator capabilities considering a highly complex reservoir model. Hence, our dynamic flow simulations take into account different properties of the geological model such as significant variation of porosity and permeability in the Stuttgart Formation as well as structural geological features implemented in the geological model such as seven major faults located at the top of the Ketzin anticline.

Integration of the geological model into reservoir models suitable for the different dynamic flow simulators applied demonstrated that a direct conversion of reservoir model discretization between Finite Volume and Finite Element flow simulators is not feasible. Hence, the initial hexahedron meshes as applied for the ECLIPSE 100 and TOUGH2-MP/ECO$_2$N simulations had to be converted into tetrahedron meshes to meet the convergence criteria of the Finite Element simulators DuMuX and OpenGeoSys.

Our simulation results show a good agreement of reservoir pressure between all simulators, while CO_2 arrival times at the observation wells strongly depend on the chosen discretization. In summary, all simulators applied are capable to address the highly complex reservoir properties present in the Stuttgart Formation at the Ketzin pilot site by dynamic flow simulations providing results of sufficient quality for prediction of future site behaviour.

References

Kempka, T.; Kühn, M.; Class, H.; Frykman, P.; Kopp, A.; Nielsen, C.M.; Probst, P. (2010) Modelling of CO_2 arrival time at Ketzin - Part I. International Journal of Greenhouse Gas Control, Special Issue Geological CO_2 Storage 4(6):1007-1015.

Martens, S.; Kempka, T.; Liebscher, A.; Lüth, S.; Möller, F.; Myrttinen, A.; Norden, B.; Schmidt-Hattenberger, C.; Zimmer, M.; Kühn, M. (2012): Europe's longest-operating on-shore CO_2 storage site at Ketzin, Germany: a progress report after three years of injection. Environmental Earth Sciences. 10.1007/s12665-012-1672-5.