EGU21-8219
https://doi.org/10.5194/egusphere-egu21-8219
EGU General Assembly 2021

Assessing wells for reuse: a probabilistic approach to well integrity using a numerical model and Bayesian belief network

Logan Brunner, Bogdan Orlic, Al Moghadam, and Jan ter Heege
TNO, Applied Geosciences, Utrecht, Netherlands (logan.brunner@tno.nl)

With increasing CO_2 emissions from fossil fuels alongside the push for more sustainable energy systems, the subsurface as a valuable asset for various sustainable energy applications has gained interest. Two primary drawbacks for the use of assets and infrastructure in transition to sustainable energy are (1) the large costs associated with new subsurface infrastructure (e.g. wells, platforms and pipelines), and (2) the detailed integrity assessment of existing infrastructure required for reuse. The concept of reusing existing infrastructure is particularly attractive as it has the potential to facilitate cost-efficient access to the subsurface for sustainable energy applications. Wells are a crucial component for reuse since they generally have a long history of mechanical loads and exposure to formation fluids prior to reuse. A common threat to well integrity is the development of fractures in the cement surrounding the well, or microannuli, at the casing-cement or cement-formation interface that may promote upward migration of fluids. This migration is often difficult to assess with conventional logs but may enable fluid communication from the storage reservoir to the overburden. Such communication is a threat for safe and efficient subsurface energy or CO_2 storage.

A methodology has been developed to model and assess the risk of well microannuli over the entire lifetime of a well (i.e. the drilling, completion, operation, abandonment, and post-abandonment phases). The basis of the assessment is a numerical model (DIANA finite element tools), in which a cross-section of the well, cement, and geology is modelled at a given depth. Deterministic parameters are incorporated to enable sensitivity analyses of results. Stochastic variables represent parameters that are uncertain but can be incorporated using a distribution of values, which are sampled using the Monte Carlo method. Probabilities of the microannulus aperture are analyzed using a Bayesian belief network approach. The results vary depending on the choice of values for the deterministic parameters, based on potential strategies of energy operators that can be modified to achieve a proper mix of risk-reduction and financial costs.

The methodology has been evaluated in the SECURe project, where it was applied to a Polish shale gas well and a (hypothetical) CO_2 injection well in the offshore Netherlands, and in the REX-CO_2 project, where it has been integrated into a tool designed to screen wells for suitability of reuse for CO_2 storage. As the approach can handle different operations and fluids, its potential exceeds these use cases. Further application in subsurface energy projects can help in addressing well integrity issues and in advising and decision-making for potential reuse of wells.

This work is part of two projects, SECURe and REX-CO_2, which have received funding from the European Union's Horizon 2020 (grant agreement number 764531) and the ERA NET Cofund ACT (project number 299681), with financial contributions made from ADEME (FR); RVO (NL); Gassnova and RCN (NO); UEFISCDI (RO); BEIS, NERC, and EPSRC (UK); and US-DOE (USA). The contents of this publication reflect only the author's view and do not necessarily reflect the opinion of the funding agencies.