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Factors influencing energy wellbore leakage in Alberta

Daniel MacDonald[1], Maurice B. Dusseault[1] and Richard E. Jackson[1, 2]
[1]Department of Earth and Environmental Sciences, University of Waterloo
[2]Geofirma Engineering Ltd.

Abstract

Wellbore leakage refers to the unwanted leakage of subsurface fluids along the annuli of oil and gas wellbores. Wellbore leakage is of concern because it may cause natural gas to enter a shallow aquifer, thereby deteriorating the water quality, or be emitted directly to the atmosphere as a greenhouse gas. Exceptionally, fluids other than CH_4 could be involved (e.g., brine, hydraulic fracture fluids, other hydrocarbon gases). Wellbore leakage has also been identified as a first-order risk issue for CO_2 sequestration projects and hydraulic fracture stimulation (particularly interaction with offset wells during fracturing).

Watson and Bachu (2009) identified major impact factors on the occurrence of wellbore leakage for wellbores spud up until 2004 and established the basis for our current understanding of wellbore leakage development. However, there is uncertainty as to whether their findings are applicable to more recently spud wellbores because drilling practices and wellbore orientation are changing rapidly. The purpose of this research has been to evaluate the influence of well design (i.e., orientation), well type (produced hydrocarbon), drilling contractor and reported drilling issues on the development of wellbore leakage among wellbores drilled over the past decade (2004-2013) in Alberta.

Consistent with past research, well design was found to have an influence on the development of wellbore leakage. Specifically, non-vertical wellbores are generally more prone to leakage problems than vertical wellbores. Also, the development of leakage problems within a particular well design was variable, depending on well type, drilling contractor and reported drilling issues. Construction challenges might explain why non-vertical wellbores are more prone to leakage problems than vertical wellbores, but cannot explain why some non-vertical wellbores were more prone to leakage problems than other non-vertical wellbores.

In contrast to previous research, a difference in the occurrence of leakage problems was found among wellbores producing different hydrocarbons. This finding was expected because some wellbores may be exposed to higher levels of operational stresses depending on the required production activities, e.g., steam-assisted gravity drainage. Furthermore, the occurrence of leakage problems among each well type appeared to be closely related to well design. This indicates that well design might also have an influence on the development of leakage problems among different well types.

A difference in the development of leakage problems was found between wellbores drilled by particular contractors. This finding might be attributed to varying internal standards and best practices implementation between companies. Alternatively, the observed differences might be an artifact of varying standards for monitoring and reporting leakage problems between companies.

Wellbores with, rather than without, reported drilling issues were found to have the lowest average occurrence rate of leakage problems. This finding was not expected, since it was hypothesized that wellbores with reported drilling issues would encounter challenges that would subsequently jeopardize the integrity of the wellbore. We speculate that this finding is the result of successful risk management of drilling issues by industry as to prevent further issues from being encountered (i.e., problems triggered more attention, leading to more care and better outcomes).

Overall, this study indicated that the occurrence of leakage problems is statistically significant as related to well design, well type, drilling contractor and reported drilling issues. This study raises questions regarding our understanding of the mechanisms responsible for the development of leakage problems. Industry and regulators might focus future research and quality assurance on problematic wellbores identified in this research.