Experimental and modelling study of wellbore integrity for CO_2 geological storage

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Abstract

Storing CO_2 in underground geological formations is considered the most effective way for a safe and definitive CO_2 sequestration, but this requires long-term wellbore integrity as an important condition to maintain the isolation of geological formations and to prevent vertical and horizontal migration of fluids through the wellbore [1]. Poor well completion of active oil and gas wells or permanent well abandonment are the main factors directly affecting the well integrity. This can lead to a serious deterioration around the wellbore, including the geochemical degradation of well cement and the casing corrosion and failure [2-4]. Therefore, deep abandoned wells represent the greatest risk for potential leakage pathways along the engineered structure, particularly among the casing-cement contact, the casing-plugs contact, the cement-rock contact, and also along/through degraded or fractured materials such as cement well plug [1] [3] [5].

The possibility of such leaks raises considerable concern about the long-term wellbore isolation and the durability of the well cement, which is used to prevent the vertical migration of fluids and/or gases through the wellbore annular space. Therefore, a cement sheath is expected to provide zonal isolation during the life of a well. It is well known the creation of gas channels and micro fractures in cement sheath results when there is a poor bonding of cement to the formation rock [3]. Accordingly, here we propose to couple a new experimental procedure and modelling tools to improve our understanding of reactivity of CO_2-brine-well cement for systems where there has been a poor bonding among the well cement and formation rock during the cementing process.

Experimental studies will be conducted under geological storage conditions using API Class G and Class H Portland cements, since they are commonly used in oil and gas well cementing. The obtained experimental data will form the input for the geochemical model using PHREEQC. These geochemical models will then be coupled with geomechanical simulations using ECLIPSE reservoir software to obtain relevant

information about some important parameters along well cement, specially porosity and permeability. Continuing changes in these parameters caused by CO_2-brine-well cement interactions can then be used to determine if the well cement will provide zonal isolation throughout its lifetime and therefore the wellbore integrity will keep intact.

References:

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