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Risk matrix for legacy wells within the Area of Review (AoR) of Carbon Capture & Storage (CCS) projects

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ABSTRACT

The success of CCS depends on the capacity, injectivity, and confinement by the storage medium. Thousands of wells drilled over the past century with the intention to find the trapped oil and gas may penetrate the containment seals. These wells may provide leakage pathways for the CO_2 to escape and contaminate the underground sources of drinking water (USDW) or reach the surface in the worst-case scenario. Identifying the risky wells penetrating the containment seals and predicting their current as well as future well integrity is the most challenging task when limited data is available. This paper proposes a unique methodology for risk assessment of the wells penetrating the containment seals based on the proximity of these wells from the proposed injection location, mechanical integrity, and accessibility of these wells over the lifecycle of the CCS project. This helps in identifying the wells which need immediate attention from the wells that need little to no attention. It also highlights the corrective actions necessary for the success of the CCS project as well as help estimate the approximate cost required to perform the corrective actions. This methodology focuses on all wells (producers, injectors, orphan, abandoned, water, stratigraphic, etc) while the majority of the studies found in literature focused on wells with sustained casing pressure (SCP) reports and cement bond logs (CBL). The proposed risk matrix, if applied to future CCS projects across the globe, will uniformly categorize the wells within the Area of Review (AoR).

1. Introduction

Carbon Capture & Storage (CCS) is a proven technology supported by regulatory policies (Benson et al., 2005). CCS refers to the safe and permanent storage of CO_2 in the subsurface primarily in the depleted oil and gas reservoirs. It is also referred to as Geological Carbon Sequestration. It holds immense potential for climate change mitigation if applied on a commercial scale (Loria and Bright, 2021). One of the applications of Carbon Capture Utilization & Storage (CCUS) refers to the injection of CO_2 to enhance oil recovery with the added benefit of storing some percentage of CO_2 in the reservoir. Oil and gas companies have the expertise needed to help build the CCS industry. There are several incentives and tax credits motivating the companies to perform CCUS and/or CCS (Jones and Sherlock, 2020).

CCS projects require drilling of Underground Injection Control (UIC) Class VI wells that are drilled for long-term permanent geologic sequestration of CO_2. CCS projects can be broadly classified into three parts - capture, transportation, and storage. The storage part can be further classified into distinct phases based on the activities performed during each phase as shown in Fig. 1. The risks and uncertainty involved in the CCS projects are initially high and decrease as the project progresses (Trabucchi and Patton, 2008). The success of CCS depends on the capacity, injectivity, and confinement by the storage medium (DOE NETL, 2017a, 2010). In geological carbon sequestration, CO_2 is captured directly from an industrial source and stored in underground porous mediums – saline aquifers or depleted oil and gas reservoirs. Their capacity and injectivity are very well-identified and the success of geological sequestration critically depends on the confinement by the containment seals – low permeability rocks (shales)(DOE NETL, 2017b). Well Integrity evaluation of all the wells penetrating the containment seals is one of the critical aspects for the site selection of Class VI wells along with the assessment of continuity and lateral variation of containment seals. These well integrity studies are an important part of Class VI well permit applications that also direct the corrective action plans. The results from well integrity studies are used to propose corrective actions on the risky wells that may provide CO_2 leakage pathways. The terminologies used in this paper like Area of Review (AoR), caprock, confining zone, geologic seal, storage complex, storage

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