Novel Laboratory Testing Technologies to Assess Suitability of Geological Storage Prospects and the Associated Risks of Carbon Dioxide Injection

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[1]Scaled Solutions

Abstract

An improved understanding of the physics and chemistry of subsurface CO_2 flow for the purposes of geological storage is required. As CO_2 is injected into the rock formation, a set of geochemical reactions occur between CO_2, brine and mineral surfaces. These reactions generate challenges associated with the injection of CO_2 into reservoirs including near-wellbore formation damage potential. This includes fines migration and the precipitation of various undesirable solids *e.g.*, scale, hydrates and ice. As with all flow assurance challenges, there are several treatments available to maintain and even enhance injectivity, however our understanding on these matters for CO_2 geological injection and storage must improve via effective replication of injection and subsequent blockage conditions at the laboratory scale. This work aims to raise awareness of operational challenges related to CO_2 injection in low-temperature and varying pressure reservoirs, providing a new approach to assess injectivity impairment (& remediation) at a practicable laboratory scale. Novel core flooding-based testing apparatus was used to measure permeability changes of a porous core medium during injection of carbon dioxide across a range of water compositions, saturations, temperatures (- 25 °C to Ambient), and pressures (< 400 bar). This work was conducted to demonstrate the effect on injectivity of various formation-damage mechanisms, including formation of CO_2 hydrates, scale and ice. The new dynamic dual phase injection test rig was designed, built, and used to assess a range of conditions expected in CO_2 injection into deep saline (high pressure) reservoirs and de-pressurised oil and gas reservoirs (low pressure). Injection of CO_2 into a brine saturated porous core medium, with simultaneous manipulation of the temperature and pressure into the hydrate formation window, resulted in severe blockages in the core sample. Adjusting temperatures and pressures at specific trajectories allowed for differentiation between CO_2 hydrates and ice blockages. Reproduction of injectivity impairment under a variety conditions, saturations and flow rates demonstrated the ability to form, dissipate, and reform CO_2 hydrates within a porous medium. This testing methodology provides the ability to test near well treatment techniques (including inhibition, remediation and induced fractures methods) which are being developed exclusively as CO_2-specific additives to manage injectivity & integrity. This paper presents new lab methodology for the dynamic assessment of CO_2 injection in reservoirs, determining under which operating conditions CO_2 injectivity can be impaired due to formation of various solids. This apparatus surpass existing methods outlined which rely on static measurements of fluids rather than dynamic measurements in reservoir core, a more representative scenario for geological carbon storage.