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Please fill in your manuscript title.	Feasibility Of CO2Storage In Depleted Gas Reservoirs Exhibiting Thermal Effects During Injection

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Abstract

Objectives/Scope: Permanent storage of carbon dioxide in deep subsurface formations is widely acknowledged as a scalable and achievable technology that can contribute significantly to the ongoing effort to limit CO2 emissions into the atmosphere. Depleted gas reservoirs are particularly appealing for a safe and effective storage of CO2. However, injecting CO2 in a depleted reservoir is associated with an injectivity challenge related to CO2 phase transition. In this work, we model the thermal and thermodynamic effects on CO2 injectivity based on experimental data.

Methods, Procedures, Process: In this work, we analyze and model lab experiments performed to replicate the Joule-Thomson (JT) cooling for CO2 injection in a 40ftslim-tube, reflecting the reservoir pressure and temperature conditions. We then consider a field case and evaluate the technical and economic viability of three potential solutions, including Nitrogen pre-injection to remove connate water from the wellbore vicinity, hydrate inhibitor additives, and CO2 surface heating. We use high-resolution, full-physics simulations to capture the governing mechanisms localized near the wellbore, including the thermodynamic phase behavior from CO2 impurity and phase transition, JT effect, brine vaporization, and corresponding salt precipitation, ice and hydrate formation, and porosity and permeability reductions.

Results, Observations, Conclusions: Geological carbon sequestration processes include entrapping CO2 in saline aquifers and hydrocarbon reservoirs in its mobile buoyant phase and in basaltic and carbonate reservoirs in its solid phase. Each technology exhibits advantages and limitations related to the storage capacity, entrapment factors, and leakage risk. Depleted gas reservoirs offer convenient storage, where the higher density of supercritical CO2 compared to natural gas can accommodate a mass amount of CO2 larger than that of the initial gas in place. However, injecting CO2 in a depleted reservoir, whose pressure is lower than the CO2 bubble-point pressure, is associated with a major challenge related to the JT cooling effect. The JT cooling occurs when CO2 flashes from its dense (liquid or supercritical) phase to its gas phase. This problem has been encountered in different fields in the North Sea, as reported by ConocoPhillips, BP, and Shell companies. This problem has been replicated in the lab. The provided experiments demonstrated that JT cooling could drop the temperature below the hydrate formation temperature leading to full clogging of the porous medium and to flow interruption. This flow assurance issue may jeopardize the operational safety and the uptime of the injection process at the field conditions. Novel/Additive Information: This work provides a comprehensive study guided by a unique set of experiments and applied to a real field case to assess the feasibility and propose solutions for CO2 storage in depleted gas reservoirs. We discuss the feasibility of various mitigation plans, including CO2 heating, hydrate inhibitors, and reservoir pre-pressurization.