15th International Conference on Greenhouse Gas Control Technologies GHGT-15

5th -8th October 2020, Abu Dhabi, UAE

Rethinking Carbon Geologic Storage Capacity: an approach with practical considerations

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Abstract

A realistic and practical understanding of storage capacity is essential during the scoping and planning phases of carbon capture, utilization, and storage (CCUS) projects. Early methodologies for storage capacity estimation (U.S. DOE, CSLF Task Force) proposed static volumetric approaches for CO_2 storage in deep saline aquifers, oil and gas reservoirs and coal beds. Albeit intended for high level, low effort regional assessments, results from these methodologies significantly overestimate capacity, in addition to providing little information for large-scale commercial decision making.

This study developed from the need to redefine carbon storage capacity in a way that it provides CCUS project developers with the information they need, not only on the size of the accessible pore volume they would require, but also –and as importantly- on the rate at which CO_2 can be injected into it considering geological, technical, and economic constraints.

To help explain our approach, we use analogies from familiar concepts used in the oil industry, such as original oil in place OOIP, oil recovery factor (Rf), ultimate oil recovery (UR), and productivity index (PI), and evaluate storage capacity as an inverse oil resource assessment problem. For example, in carbon storage terminology, the simple static volumetric estimation of capacity that results from the product of net volume, average effective porosity and displaceable saturation is equivalent to OOIP. But just as not all the OOIP can be produced, not all the static volumetric capacity can be accessed by CO_2.

The recoverable amount of oil originally in place (UR) is estimated by multiplying OOIP by Rf. Similarly, in volumetric based methods, the accessible capacity (equivalent to UR) is estimated by multiplying the static volumetric capacity by an efficiency factor, such as the one used in the U.S. DOE methodology (E). However, arriving at such factors requires previous knowledge of either oil production or CO_2 injection, which is a particular challenge in carbon storage projects where this information is much more limited. Modeling CO_2 injection is valuable for this reason as it allows for dynamic assessments, where accessible capacity (also referred to as dynamic capacity) is controlled by pressure and boundary conditions.

Even if an acceptable range of accessible capacity is estimated, it is still not enough information for project developers. In an oil resource evaluation where production rates are of utmost importance, because they control the rate of return, time is a critical parameter. In a storage resource evaluation, time is also a critical parameter that should not be separated from the concept of storage capacity. CCUS developers need to know the time it will take them to access the pore space, with “time” being a function of geology (Kh), technology (well injectivity index), and economics (number of required injection wells).

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In this paper, we think of geologic storage capacity as the rate at which CO_2 can be technically and economically injected into an accessible pore volume for a period of time constrained by either a maximum injection pressure or a geologic boundary.

We applied this concept to a region in the Offshore Northern Gulf of Mexico to understand the opportunities of its oil and gas fields. To estimate the accessible storage capacity we used EASiTool (Enhanced Analytical Simulation Tool) capacity calculator, a closed-form analytical solution in a public Windows application that provides fast, yet reliable estimates in any geologic setting. Results will be provided in a paper if this abstract is accepted.

Keywords: Geologic storage capacity, carbon storage capacity, dynamic storage capacity, CCS, CCUS.