Effective Storage Capacity Study in a Deep Saline Aquifer within a Young Sedimentary Basin

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Abstract

The thermal power plant which belongs to Taiwan Power Company is the largest CO_2 emitting source in Taiwan. The problem of CO_2 emission will be a major issue in the world. Resultantly, in 2008, Taiwan Power Company launched a project to look for sites suitable for CO_2 geological storage in Taiwan. After 3 years of research, Taiwan Power Company choose the Tai-hsi basin to be the candidate site for CO_2 geological storage.

This article illustrates properties of the target site that is suitable for CO_2 storage. We established a three dimension geological model for the storage site, and evaluated the effective capacity by using a GIS tool and the unit grid conception.

The Tai-hsi basin is a serially young sedimentary formations formed during the late Miocene to early Pliocene under the western offshore near Taiwan island. The biggest thermal power plant is located on it. The advantage of the Tai-hsi basin site is transportation costs would be lower and public perception and acceptance of Carbon Capture and Storage(CCS) would be good. According to study results, we can conclude the properties of Tai-hsi basin are as followes.

1. Tai-hsi basin is a good CO_2 storage site which has a broad covering, low permeability shale as a cap rock, and high porosity and thick sandstone as a reservoir rock. Few tectonic structures cut through cap and reservoir rock layers, so there are very few earthquakes in Tai-hsi basin region. The geothermal gradient in Tai-hsi basin is cold basin type, thus an advantage to storage of CO_2 in super critical phase.

2. The cap rock in the Tai-hsi basin is of the Chinshui shale formation which distributes broadly and covers the entire area above the reservior rock. The thickness of Chinshui shale is about 30 to 100 meters, the depth ranges from 2,200 to 2,300 meters and the pororsity is about 8% to 17.54%. There is no active fault passing through this layer. The tectonic stress is in a pressure condition which closes the fractures. The fewer fractures means that the CO_2 leaks will be reduced.

3. The reservoir rock in Tai-hsi basin is of the Kueichulin formation. The sandstone in the Kueichulin formation is a coarse grain, high permeability sandstone. The average thickness is about 140 meters, the reservoir depth is 800 to 2,400 meters, the pororsity is 15.11% to 23.53% and the geothermal gradient is about 20℃/1km. This study suggests four storage scenarios for CO_2 storage capacity evaluation according to the uncertainties of geological conditions. The storage volume of the four scenarios varies from 212.66 to 350.33 km^3 range.

4. This study suggested an evaluating formula for storage quantity based on the America Department of Energy (DOE) and Japan RITE. This formula considers the reservoir volume, sandstone percentage in reservoir rock, density of CO_2, storage effect and supercritical CO_2 saturation (Sg), and then multiplies them to get the effective capacity. This research used a 3D geological model to create GIS unit grids with 1,000m×1,000m resolution. There are 2,589 grids and each grid has attributes such us depth, thickness, porosity and CO_2 density. We use the GIS system to calculate the storage quantity of each grid, and then add them together as the total storage quantity of Tai-hsi basin site. According to four storage scenarios , the storage capacity range could vary from 3.7 billion to 6.0 billion tons in the Tai-hsi basin site.

5. Due to the limitation of actual geological storage parameters for Taiwan, the effective capacity calculation refers to the storage pyramid conception. We will increase the precision of effective capacity when getting more experimental data and apply results to commercial purpose in the future.