Numerical Study on Multi-Scale Diffusion of CO2 Leaked from Seafloor of Southeastern Coast of Korea during Ocean Geological Storage

Se-Min Jeong(smjeong@chosun.ac.kr)[1], Seokwon Ko[1], Jong-Chun Park[2]
Henzeh Leeghim[3], Chang-Yull Lee[3]
[1]Department of Naval Architecture and Ocean Engineering, Chosun University, [2]Department of Naval Architecture and Ocean Engineering, Pusan National University, [3]Department of Aerospace Engineering, Chosun University

Abstract

Carbon Capture and Storage (CCS) is a technology to capture CO2 from power stations or industry processes without emitting it to the atmosphere, transport it to sites suitable for geological sequestration, and store it stably underground for a long term. With its larger potential to lower CO2 emissions at an early stage, CCS is expected as a key option to mitigate global warming. CO2 is injected into porous geological layers such as aquifers or oil and gas reservoirs at depths below 1000 m onshore or offshore underground. The geological storage of CO2 under the seafloor is one of the feasible options to Korea since the available inland sites for geological storage is very limited. However, in this type of storage there may be a risk of CO2 leakage through direct faults or boreholes, and it may impact marine organisms near the leakage sites. In addition, unless all of the leaked CO2 dissolves in the seawater, some will come back into the atmosphere. Therefore, it is necessary to predict the impact of CO2 dispersing from the cracks in the seabed topography to the ocean.

In this study, numerical simulations were conducted to predict the change of partial pressure of CO2 (pCO2) in the ocean caused by CO2 leaked from seafloor of Korean coast. For the numerical simulations, a multi-scale (hybrid of fully three-dimensional (3D) small-scale model and hydrostatic-pressure assumed mesoscale model) ocean model, which was originally developed by JASNAOE(2003) and further improved by Kano et al.[1] for the simulation of the CO2 bubble/droplet two-phase flows in the small-scale domain, was used. In the mesoscale model, tidal flow is dealt with under the hydrostatic-pressure assumption to reduce computational loads. Simultaneously, the CO2 bubble/droplet two-phase flows are simulated and analyzed with adopting an Eulerian–Lagrangian two-phase model, in which the movement of the dispersed phase is analyzed by solving the motion equation of individual bubbles. CO2 takes the form of bubbles, and their behavior and dissolution are numerically simulated during their rise in the water column. The advection and diffusion of the mass concentration of dissolved CO2 (DCO2) leaked from the fault is also predicted.

[Acknowledgement]
This research was supported by Basic Science Research Program through the National Research Foundation of Korea(NRF) funded by the Ministry of Education(No. 2017R1D1A3B03030031).

Keywords: *Ocean geological storage of CO2, Multi-scale ocean model, Two-phase flow, CFD(Computational Fluid Dynamics)*

References

[1] Kano, Y., Sato, T., Kita, J., Hirabayashi, S., & Tabeta, S. (2010). “Multi-scale modeling of CO2 dispersion leaked from seafloor off the Japanese coast”. Marine pollution bulletin, 60(2), 215-224.

Biography

Se-Min Jeong is currently an assistant professor at Department of Naval Architecture & Ocean Engineering, Chosun University, Korea. He got his M.S. from Dept. of Naval Architecture at Inha University, Korea, in 1997 and Ph.D. in Environmental & Ocean Engineering from the University of Tokyo, Japan, in 2007. He has 15 years of experiences in the industry and academic field. His research interests are in the areas of computational physics especially regarding multi-phase (thermal) turbulent flows.