

CO₂ Fixation Technology in Controlled Coastal Landfill Sites During the Post-Closure Maintenance Period

CO₂ Fixation Technology at Coastal Landfill Sites

Focusing on the neutralization of alkalized retained water at the Kinuura Port No. 3 landfill site due to the dissolution of carbon dioxide (CO₂) from the atmosphere, we are conducting research to quantitatively evaluate its ability and estimate the reaction mechanism.

Toyo Construction Co., Ltd. has concluded a joint research agreement with the National Institute of Port and Airport Technology on the Evaluation of Atmospheric Carbon Dioxide Removal at Controlled Sea Level Landfill Sites, and is conducting research and evaluation under their guidance.

Calculation of the Amount of Retained Water due to the Dissolution of CO₂ in Retained Water at the Site

● Natural Dissolution of Atmospheric CO₂

Atmospheric CO₂ naturally dissolves in the alkaline water surface of disposal sites. The amount of CO₂ is 5 ~ 10 times that of normal seawater, and disposal sites have a large potential for storing CO₂. This dissolution flux is affected by the pH and temperature of the retained water, the concentration of CO₂ in the water, disturbances in the water surface, and the presence of phytoplankton.

● Water Quality at Disposal Sites

In the summer, a thermocline occurs, and there is a high-salinity water mass in the deep layer characteristic of disposal sites.

● Survey Method

The gas phase CO₂ concentration in the container floating on the surface of the water at the site is in equilibrium with the water CO₂ concentration. The amount of CO₂ dissolved per hour was evaluated by measuring the change in CO₂ concentration in the gas phase.

● Survey Results

As a result, the concentration of CO₂ in retained water at pH 9 ~ 11 was less than 100 ppm, indicating that CO₂ is always dissolved in one direction from the atmosphere.

● Calculation Method of Dissolution Flux

Dissolution flux of CO₂ is calculated by the following equation:

$$F = 4.71 \times 10^{-4} \times V(C_1 - C_2)/A$$

where *F*: CO₂ absorption flux (kg-CO₂/ha/day)

V: Gas phase volume (L), *A*: Container cross-sectional area (m²)

*C*₁: Initial CO₂ concentration in the gas phase (= 400 ppm)

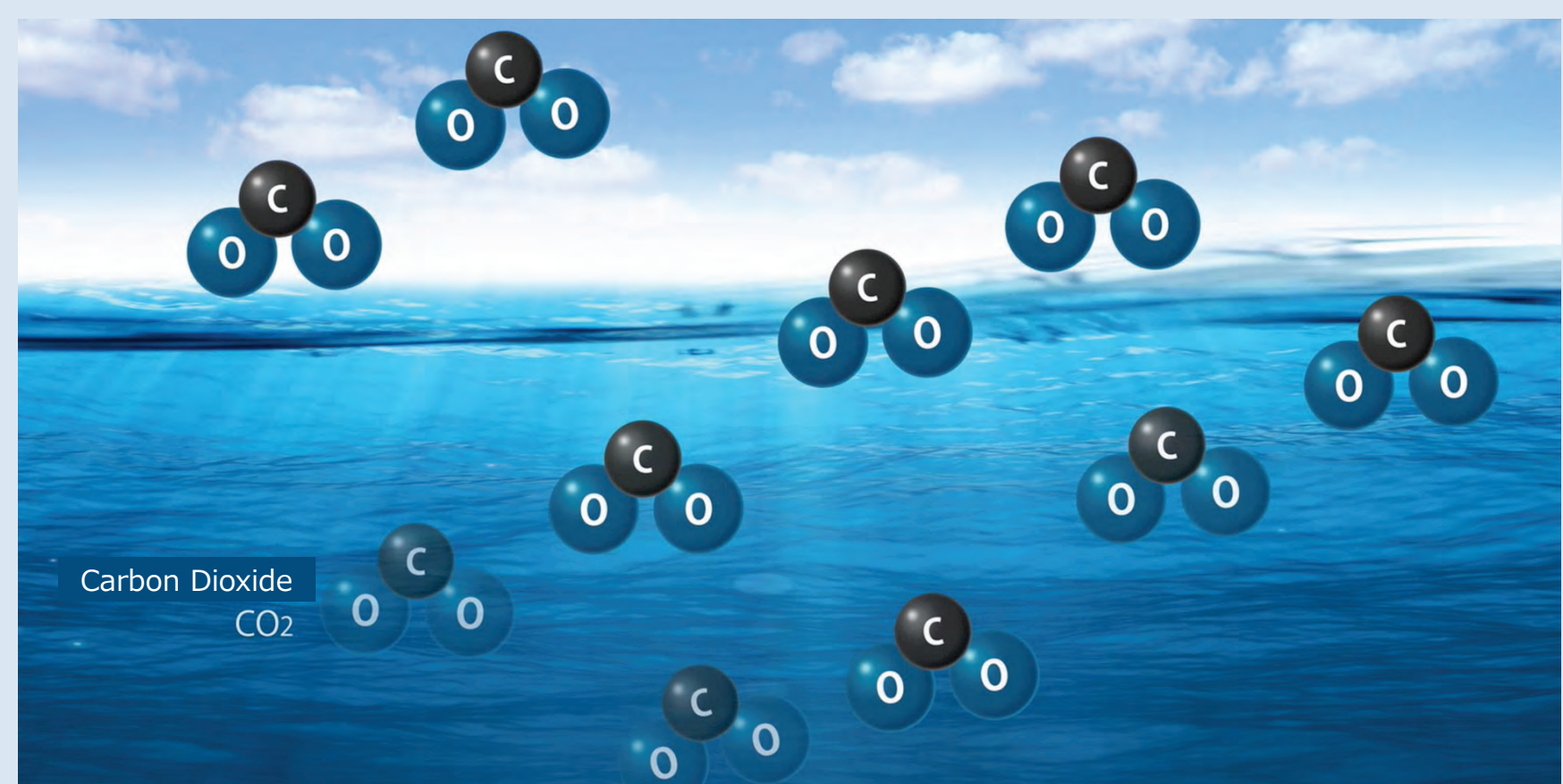
*C*₂: CO₂ concentration 1 hour after the initial gas phase (ppm)

*The coefficient are the unit conversion values

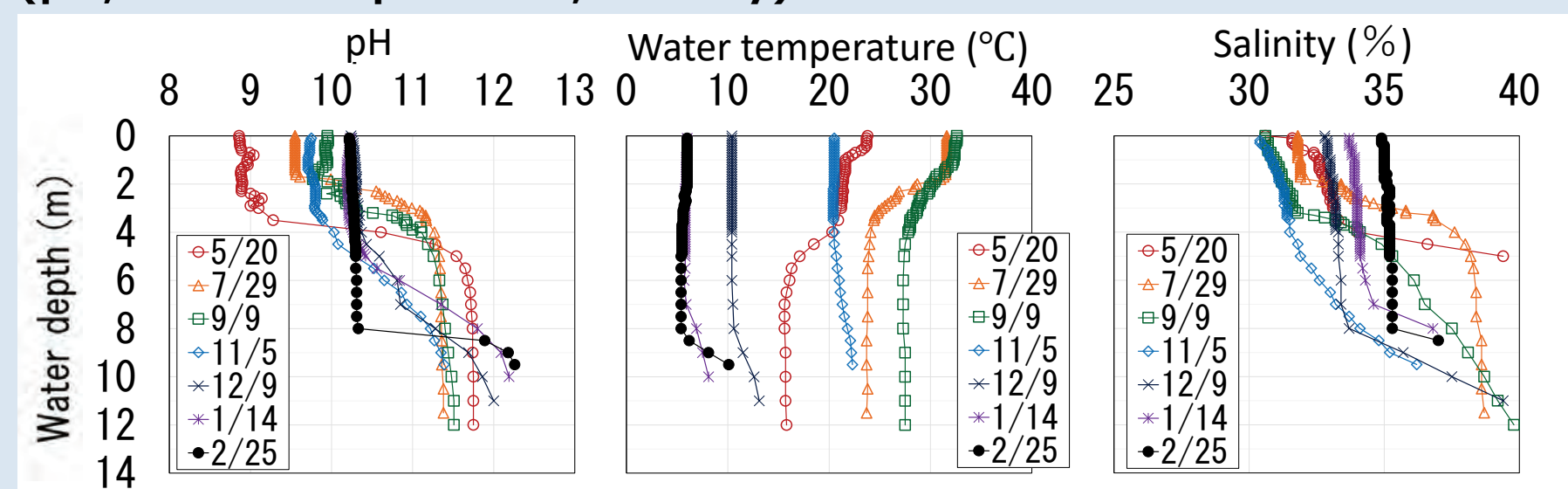
● Storage volume per disposal site

In FY2023–2024, the dissolved flux tended to increase from summer to autumn. The dissolved CO₂ flux was approximately 15–30 kg-CO₂/ha/day, corresponding to about 5.5–11.0 t-CO₂/ha/year.

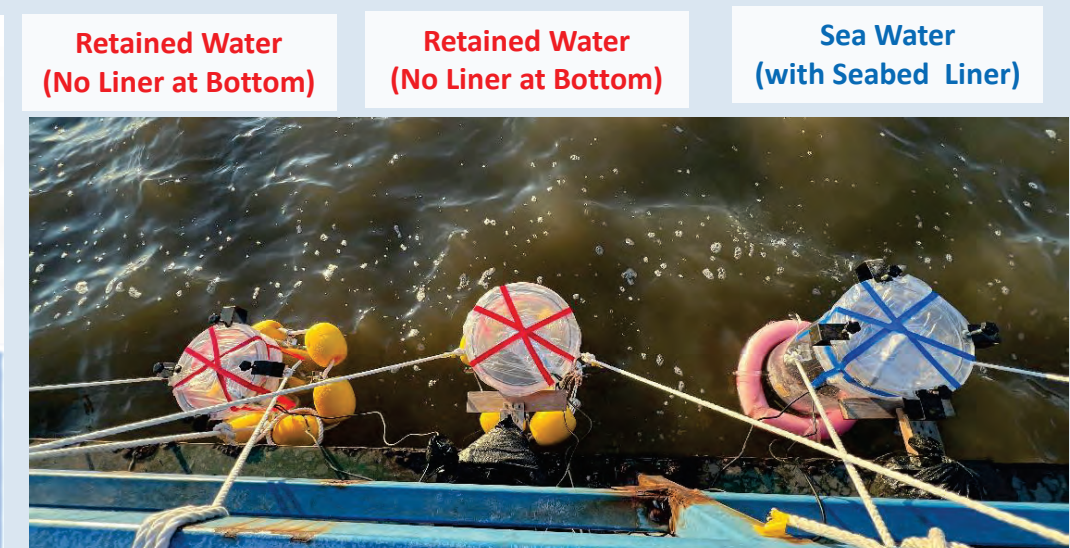
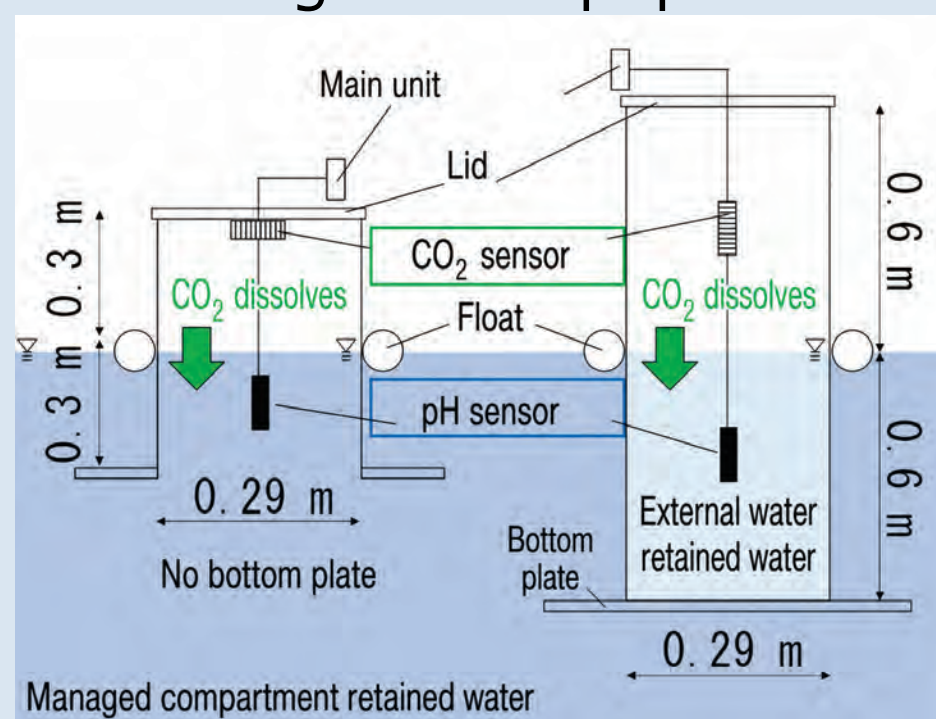
■ Image of CO₂ dissolution in the atmosphere



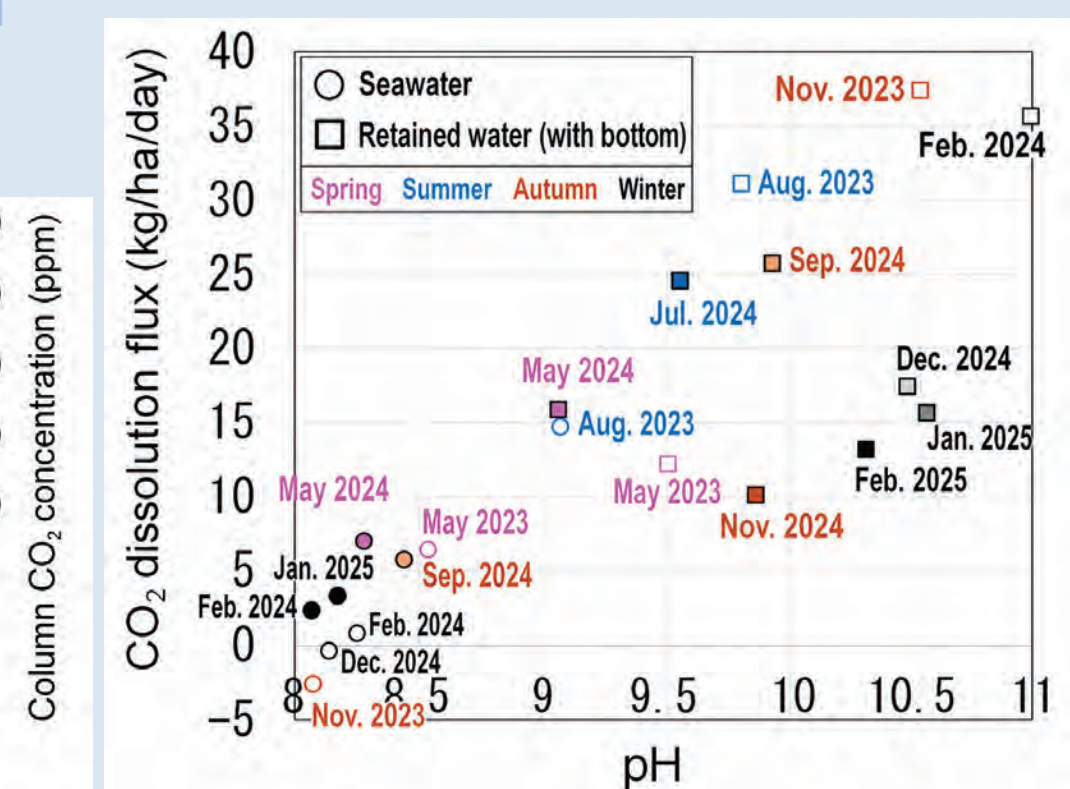
■ Vertical distribution of water quality (pH, water temperature, salinity)



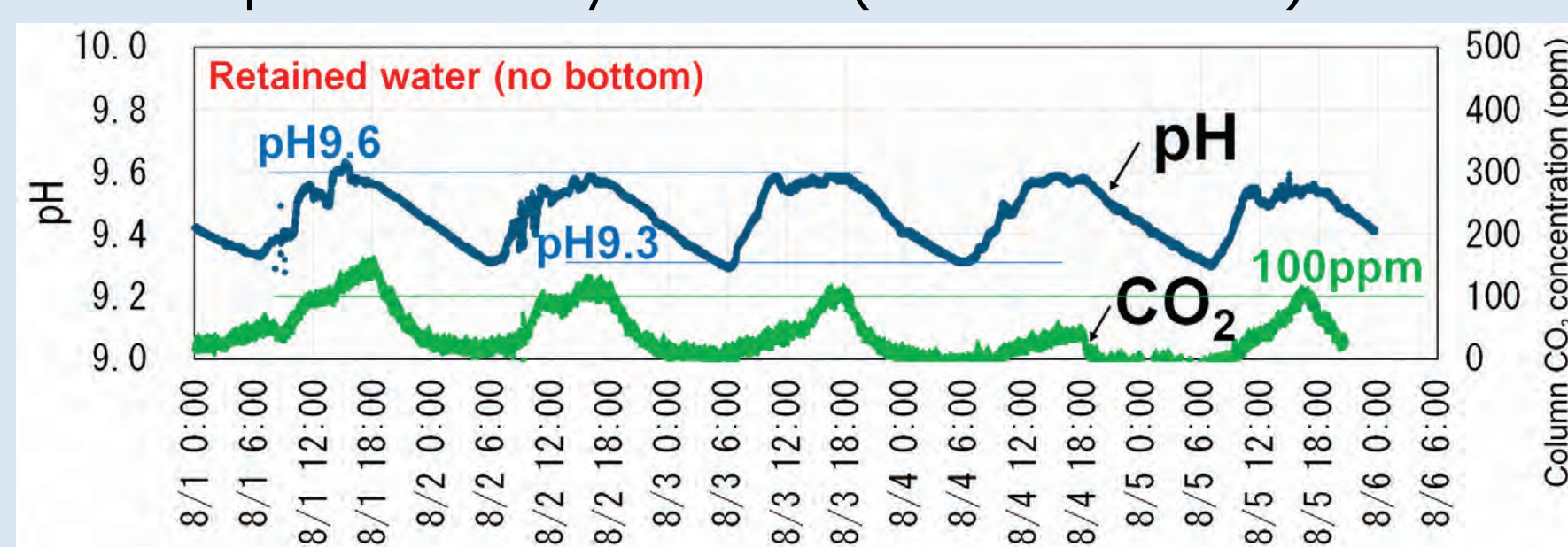
■ Investigation equipment



■ Flux Fluctuations (FY2023~24)



■ Example of survey results (Summer 2024)



[Challenges] In the future, methods to increase the dissolution flux, utilization of exhaust gas, and evaluation of the certified volume will be conducted.

[Initiatives] Efforts will be made to establish a precedent model for using a managed sea-level repository as a CO₂ storage facility.