Effectiveness of CO2 Ocean Sequestration for Acidification of the Ocean

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The acidification of the ocean is pointed out with the global warming issue (Caldeira & Wickett, 2003). The possibility of the carbon dioxide ocean isolation technology was examined as a measures technology of this problem. In order to control global warming and acidification of the ocean, it is necessary to decrease the discharge of CO2 into the atmosphere. In a lot of past calculations, the CO2 emission over several centuries causes the increase of atmospheric CO2 concentration, and the pH of surface of the oceans decreases during taking up CO2, and finally, the atmospheric CO2 concentration decrease in equilibrium. If captured CO2 is injected to mid-depth layer without contacting the sea water of surface layer, so, the marine organism of the surface layer is not affected by the injected CO2. Injected CO2 to mid-depth is dissolved into the sea water as well as the atmospheric CO2 is naturally absorbed to the ocean. From the viewpoint of suppressing environmental impact to the minimum extent, RITE is developing a dilution & injection technology to the middle and deep ocean layer using Moving Ship approach. The project goal of the second phase started in 2002 is the assessment of ocean sequestration validity, the development of environmental impact assessment technology and the development of CO2 dilution technology.

A close-up of the problem of ocean acidification has been taken recently (Caldeira & Wickett, 2003). However, the effect of ocean sequestration to the acidification of the ocean has not been researched. We made a comparative study using 3-dimensional numerical model for understanding of effectiveness of ocean CO2 sequestration. Understanding of effects of the CO2 ocean sequestration were simulated numerically by using 3D global model including This model consist of an ocean circulation model and a global carbon cycle model based on an ecosystem model (a lower trophic model). The size of grid was 4 degree horizontally and 30 layers vertically.

To evaluate of CO2 ocean sequestration for the acidification of ocean surface layer, two cases were calculated as an extreme condition. One is the reference case which discharges all of CO2 emission in the world into the atmosphere, and the other is ocean sequestration case which injects into the deep ocean. Amount of CO2 emission was setup considering B2 scenario until year of 2100 and available fossil fuel after year of 2100. In the ocean sequestration case, the amount of annual emission in the world was divided into seven, and it was injected into each site of layers between 1,000 - 2,000m. These seven sites were set up according to Orr et al. [2000].

In the comparison of the calculation results, it was shown to suppress the pH decrease in the marine surface layer when the CO2 ocean sequestration was done. The pH of the ocean surface layer becomes a minimum in around 2300 when all carbon dioxides are discharged to atmosphere. At this time, delta-pH became about -0.6. Afterwards, delta-pH recovered up to about -0.4 in 3000 when the CO2 concentration of atmosphere was steady. On the other hand, the pH of the marine surface layer decreases gradually when oceanic isolation of carbon dioxide is executed. And, it became the same pH in case of the atmospheric discharge in 3000. Moreover, it became distribution almost corresponding to the atmospheric emission case for 3000 though the decrease in the pH was caused in and middle and deep layer.

In conclusion, on the comparison of ocean sequestration case and reference case, it was shown that CO2 ocean sequestration technology had the effect of delaying for decrease speed of pH in the surface layer and the effect of keeping a little decrease of pH. If the ecosystem impact of the deep depth is permitted, it was suggested that ocean sequestration was a mitigation technology for acidification of ocean surface layer.