Evaluation of injectivity of liquid CO2 in CO2 hydrate storage

*Takaomi Tobase[1], Shouji Yukiko[1], Nishiyama Haruki [2], Shigeoka Yuuki [2], Kinoto Hiroshi[2]

1. Electric Power Development Co., Ltd., 2. J-POWER Business Service Corporation

Approximately 1.2 billion tons of CO2 is currently emitted annually in Japan. 40% of it (0.5 billion tons) is due to the electric power sector. The Japanese government plans to reduce greenhouse gas(GHG) emission by 80% by 2050. It is necessary to reduce the emission from the electric power sector to be nearly zero to achieve the target. According to the power supply scenario of 2050, 40% of the total energy will be generated by thermal power (coal and natural gas) with CCS, assumed that non-fossil energy, i.e. renewable energy and nuclear energy covers 60% of it. In this case, the quantity of storage of CO2 by CCS will be 200 million tons a year (= 500 million tons X 0.4).

As for the geological storage of CO2, aquifer storage and CO2-EOR are common now. In Japan, since there are few conventional oil and gas fields, CO2-EOR cannot be expected. Survey on suitable sites of aquifer storage is currently underway in Japan. However, there is not certain information whether sufficient storage sites can be secured to inject 200 million tons a year. In such situation, it is urgent to increase the suitable storage sites to achieve the goal of 80% reduction before 2050 (30 years later).

In this study geological storage of CO2 using hydrate mechanism is proposed as a new storage method. Trapping mechanism of this method (used hydrate mechanism) depends on temperature and pressure condition to produce hydrate, but not the cap rock as a geological structure. Investigation of temperature and pressure conditions in the sea area around Japan (deep sea area) revealed that the conditions to generate CO2 hydrate are satisfied in a wide area. The concept of the CO2 underground storage using hydrate mechanism is referable in the proceedings of JpGU2019. The issues of the CO2 underground storage using hydrate mechanism are, 1) quantitative evaluation of permeability drop mechanism during hydrate generation in geologic strata for prevention of CO2 leakage (securing seal performance), 2) evaluation of injectivity of liquid CO2 injected and stored in the lower strata of hydrate generation area.

In this report, the injectivity of liquid CO2 is discussed. With a supposed geological condition of sub-seabed, a simulation was performed by setting the density, viscosity and phase state of the injected CO2 corresponding to the temperature and pressure conditions. As a result, it is clear that there is no significant difference in the injectivity of liquid CO2 between the conditions of temperature 20℃ / pressure 15MPa and that of the super critical CO2 of temperature 35℃ / pressure 20MPa. This suggests that injection with liquid CO2 is appropriate. In this study, the relative permeability of the super critical CO2 is used. When the data of the relative permeability of liquid CO2 is available an evaluation of the injectivity of liquid CO2 will be done again with higher accuracy.

Keywords: CCS, carbon storage, gas hydrate, seal function , injection performance

