Considering of a CO2 storage technique using shallow aquifer

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http://unit.aist.go.jp/energy/groups/fc-sys.htm

Increasing CO_2 emission to the atmosphere by resent industrial activities has been considered to cause global climate change and disturbances to wide regions (IPCC 4th report). Therefore mitigation of CO_2 emission to the atmosphere is emergent and worldwide task.

In many CO_2 mitigation options, adaptation of onsite power systems is an effective option because the system allows effective use of high-efficient electrical generation or renewable energy without distribution loss of electricity and heat. For example, SOFC (Solid Oxide Fuel Cell) has high electrical efficiency on about 1-1000 kW output power scale and has been expected to be used as small power plant built in onsite power system and co-generation system. In addition, SOFC systems are also expected to make it possible to null net CO_2 emission (carbon neutral) using hydrocarbon gas extracted from biomass.

On the other hand, a technique in which CO_2 emitted from industrial facility (e.g., heat power plant) is captured and isolated from atmosphere by storing CO_2 into underground or deep sea has been studied as another CO_2 mitigation option (CCS: CO_2 Capture and Storage). Among CO_2 storage techniques, underground geological storage in which CO_2 is stored into underground at depth more than 800 m is the most viable one at present. The storage capacity by underground geological storage is estimated more than 1000 Gt-CO_2 in the world (IPCC 4th report).

No single technology can provide enough CO_2 mitigation potential by estimation of IPCC, and therefore several options should be adapted concurrently. For one thing, capturing CO_2 emitted by an onsite power plant and storing in underground increases CO_2 mitigation potential. In particular, because emission gas from SOFC can be prevented from dilution with nitrogen gas in air, energy using for capturing CO_2 is estimated to be smaller than those of other systems in which air is used as oxidant. Therefore combination of SOFC and CCS is also expected to have advantage in CO_2 capturing.

However existing underground geological storage techniques are composed assuming utilization for large heat power plants which emit large CO_2, therefore application to onsite power plants has problems of cost and adoption of storage site, and is unrealistic way considering CO_2 transport cost and energy loss. In addition, existing underground geological storage technique cannot be applied to isolated island regions in which power plants (mostly internal combustion power plant) are small and dispersed geographically.

The cause of above problems is geological limitations of existing geological techniques; the storage depth should be more than 800 m (=expensive capital requirement for one storage well) and enough large seal bed should exist over storage site due to CO_2 storage state. If CO_2 can be stored in shallower site without large seal bed, CCS applicable to onsite power plant should be possible.

In this study, we advocate a new CO_2 storage technique in which CO_2 is stored in dissolved state. Dissolved CO_2 into water is difficult to disperse by concentration difference than gaseous and supercritical CO_2, and upwelling by buoyancy is not occurred in underground aquifer. Therefore, if CO_2 fugacity of CO_2 solvent water is smaller than total pressure and advection diffusion can be ignored at storage site, CO_2 can be stored stably even in aquifers at the depth less than 800 m. This new storage technique does not have the above existing limitation and can be applied to CCS for onsite power plants. The potential and cost of CO_2 storage by this technique will be evaluated at presentation of the day.