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HRE28-05 Room:105 Time:May 25 10:15-10:30

Trend in the development of microbial technology in CCUS: a bottleneck in the realization of geo-bioreactors

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Carbon dioxide capture and storage (CCS) is the primary technological option to reduce CO_2 emission into the atmosphere. Furthermore, carbon capture, utilization, and storage (CCUS) has recently become widely recognized as a CO_2 reduction measure. CO_2-enhanced oil recovery (EOR) is profitable owing to oil production and is considered a major CCUS technology. It also provides economic incentives for CO_2 utilization. An ecologically sustainable energy production system using CO_2-EOR that yields additional economic incentives has been proposed. The proposed system uses the microbial conversion of injected CO_2 into methane in oil reservoirs[1)]. It is expected that oil reservoirs have applications as geo-bioreactors and can be used as microbial energy production systems in subsurface environments (Fig.1)[2,3)]. In this process, hydrogen that is required for methanogenesis supplies by degradation of hydrocarbons via thermophilic fermentative bacteria in oil reservoirs. However, *in situ* methanogenesis after injections of CO_2 has also been demonstrated[2,4)]; the thermodynamic process that results in anaerobic hydrogenesis from hydrocarbons such as hexadecane in oil reservoirs is unlikely to occur[5)]. There is a major problem associated with maintaining a stable supply of hydrogen for methanogenesis in oil reservoirs. A solution for this issue will be a breakthrough in geo-bioreactor technology.

To date, feasibility studies of the bioconversion of CO_2 to methane in domestic and foreign oil fields based on laboratory tests have been carried out. 16S rRNA survey of DNA extracted from production water confirmed the existence of thermophilic hydrogenotrophic methanogens such as *Methanothermobacter* spp., mesophilic hydrogenotrophic methanogens such as *Methanoculleus* spp. and *Methanofollis* sp., and thermophilic hydrogen-producing fermentative bacteria such as *Thermotoga* sp., *Thermoanaerobacter* spp. *Thermodesulfobacterium* spp., and *Desulfotomaculum* sp. in oil reservoirs. Laboratory gas production tests under high-temperature and high-pressure conditions were performed. Using *Methanothermobacter* sp., *Thermotoga* sp., or *Thermoanaerobacter* sp. as model microbes, methane and hydrogen production under reservoir conditions was observed.

These results demonstrated the potential for microbial conversion of injected CO_2 into methane in oil reservoirs, and highlighted some difficulties in the realization of geo-bioreactors. The number of microbes in oil reservoirs is low; generally, their density is less than 10^4 cells per ml of reservoir brine. In particular, hydrogen-producing fermentative bacteria were not highly represented in the oil reservoir microbial community. A stable supply of hydrogen would be difficult to achieve using these microbes. With respect to biomass, few microbes were available to activate microbial reactions. The shortage of microbes in subsurface environments is one of the bottlenecks in the realization of geo-bioreactors. To remove this bottleneck and establish geo-bioreactor technology, the development of effective microbial growth controls and environmental improvements suitable for microbial activity in subsurface environments is essential.

References,
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Keywords: bioconversion of CO2 to methane, geo-bioreactor, oil reservoir

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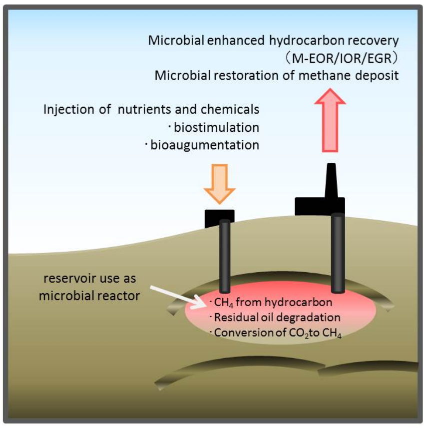

Fig. 1 Schematic representation of geo-bioreactor system [3)]