Formate-Dependent Microbial Conversion of CO_2 and the Dominant Pathways of methanogenesis in production water of high-temperature oil reservoirs amended with bicarbonate

GUANG-CHAO YANG[1], LEI ZHOU[1], SERGE MAURICE MBADINGA[1], JIN-FENG LIU[1], JI-DONG GU[2], BO-ZHONG MU[1,*]

[1] State Key Laboratory of Bioreactor Engineering and Institute of Applied Chemistry, East China University of Science and Technology, Shanghai 200237, P.R. China (guangchaoyang@mail.ecust.edu.cn, leizhou@ecust.edu.cn, smmbadinga@ecust.edu.cn, ljf@ecust.edu.cn, meor@ecust.edu.cn, jdgu@hku.hk, *correspondence: bzmu@ecust.edu.cn)

2 School of Biological Sciences, The University of Hong Kong, Pokfulam Road, Hong Kong, P.R. China (jdgu@hku.hk)

CO_2 sequestration in deep-subsurface formations including oil reservoirs is a potential measure to reduce the CO_2 concentration in the atmosphere. However, the fate of the CO_2 and the ecological influences in Carbon Dioxide Capture and Storage (CDCS) facilities is not understood clearly. In the current study, the fate of CO_2 (in bicarbonate form) (0~90 mM) with 10 mM of formate as electron donor and carbon source was investigated with high-temperature production water from oilfield in China. The isotope data showed that bicarbonate could be reduced to methane by methanogens and major pathway of methanogenesis could be syntrophic formate oxidation coupled with CO_2 reduction and formate methanogenesis under the anaerobic conditions. The bicarbonate addition induced the shift of microbial community. Addition of bicarbonate and formate was associated with a decrease of Methanosarcinales, but promotion of Methanobacteriales in all treatments. Thermodesulfovibrio was the major group in all the samples and Thermacetogenium dominated in the high bicarbonate treatments. The results indicated that CO_2 from CDCS could be transformed to methane and the possibility of microbial CO_2 conversion for enhanced microbial energy recovery in oil reservoirs.