METHANE RECOVERY FROM HYDRATE-BEARING SEDIMENTS BY N₂-CO₂ GAS MIXTURE INJECTION: EXPERIMENTAL INVESTIGATION ON CO₂-CH₄ EXCHANGE RATIO

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ABSTRACT
Carbon dioxide (CO₂) injection has recently been of interest as a method for methane recovery from low-temperature permafrost hydrate reservoirs. This paper studies the efficacy of N₂-CO₂ gas mixture injection method in recovering methane from hydrates. We conducted experiments of injecting N₂-CO₂ gas mixture (60% CO₂) into hydrate-bearing cores of different methane hydrate saturations. Gas was injected at about 80 cm³/min (STP) under controlled conditions of production pressure (7 MPa) and ambient temperature (4°C, 7°C). Data on injection pressure, gas production rate, gas composition of production fluid and core surface temperatures were sequentially recorded during the experiment. We observed that gas was smoothly injected without any increase in injection pressure and the produced gas composition finally reached the same value of injection gas, but CO₂-CH₄ exchange ratios in methane hydrate were low: about 30% for low hydrate-saturation cores, and only 5% for high hydrate-saturation cores. These low exchange ratios were probably caused by rapid formation of N₂-CO₂ hydrate film at the contact interface when methane hydrate was exposed to the gas mixture in the core. The kinetic factor in diffusion through the film seemed to affect the efficacy of CO₂-CH₄ exchange reaction in methane hydrate.

Keywords: methane hydrate, production, gas mixture, CO₂-CH₄ exchange, porous media

INTRODUCTION
The depressurization method is thought to be the most effective for recovering gas from methane hydrate-bearing sediments, but it does not work well for low-temperature sediments because this method uses the sensible heat of sediments as energy for hydrate dissociation [1]. Carbon