Experimental Study on Methane Production from Hydrate-Bearing Sandstone by Flue Gas Swapping

Methane recovery from artificial hydrate-bearing sandstones by simulated flue gas swapping was tested using a core flooding experimental setup. Seven groups of experiments were conducted to investigate the effect of hydrate saturation as well as the initial porosity and permeability of sandstones on methane production and carbon dioxide capture. The results show that the CH₄ recovery efficiency and the amount of CO₂ captured increase with the increase of hydrate saturation at the same initial porosity and permeability of sandstone. The highest CH₄ recovery obtained is 51.6% and 99.4% of CO₂ in simulated flue gas is sequestered in the hydrate phase after swapping at 9.2 MPa and 277.15 K. Hydrate saturation was 82.5% and the initial porosity and permeability of sandstone are 25.1% and 49 mD, respectively. With the increase of initial porosity and permeability of sandstone, the CH₄ recovery efficiency and the amount of CO₂ captured increase when other conditions (the hydrate saturation and reaction time) are similar. For investigating the CH₄–flue gas swapping mechanism, a microdifferential scanning calorimetry was used to test the heat changes in the whole reaction. No noticeable endothermic or exothermic phenomenon was detected in the CH₄–flue gas swapping, which indicates that CH₄ hydrate would form mixed hydrates directly instead of going through a dissociation and reformation process. Based on the observed experimental results, a CH₄–flue gas swapping mechanism is proposed and the reaction process is found to be essentially controlled by mass transfer.

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