

Effects of structural transformation and feed gas ( $\text{CO}_2 + \text{N}_2$ ) compositions on replacement efficiency in the sH  $\text{CH}_4 + \text{MCP}$  hydrate

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Natural gas hydrates have been considered as future energy due to the large amount. Replacement method has been studied as a promising production technology which has a dual function of both  $\text{CH}_4$  production and  $\text{CO}_2$  sequestration. In this study, the influence of  $\text{CO}_2 + \text{N}_2$  injection into structure H (sH) hydrate was investigated to reveal the effects of structure transition and feed gas compositions on replacement efficiency. Feed gases with various compositions ( $\text{CO}_2$  20%, 40%, and 60%) were injected into  $\text{CH}_4 + \text{methylcyclopentane}$  hydrate for replacement. The efficiency was measured using gas chromatography and the structure transition was confirmed through  $^{13}\text{C}$  NMR and powder X-ray diffraction. For the  $\text{CO}_2(20\%) + \text{N}_2(80\%)$  replacement, the extent of replacement was quite low (62%) and there was no structural transition. With an increase in  $\text{CO}_2$  concentration of the feed gas, the larger fraction of structure I (sI) due to the structural transformation was observed. However, the replacement efficiency was found to be highest for the feed gas of  $\text{CO}_2(40\%) + \text{N}_2(60\%)$ . The overall experimental results can contribute to a better understanding of the replacement mechanism in the sH -  $\text{CO}_2 + \text{N}_2$  replacement.