Experimental Study on a New Enhanced Gas Recovery Method by Nitrogen Injection from a Methane Hydrate Reservoir

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Methane hydrate (MH) is one of the potential resources of natural gas in the near future, because it exists in marine sediments or in permafrost regions worldwide. Some extraction methods of MH from the reservoir have been proposed, such as depressurization, thermal stimulation and inhibitor injection. These are all based on the in-situ dissociation process of MH that is transformed into methane gas and water. However, There are some technical and economical problems for operation of these methods. Therefore, we have proposed a new enhanced gas recovery method by nitrogen injection. Nitrogen has the effect as an inhibitor as well as methanol and salts to shift an equilibrium condition of hydrate to high-temperature and low-pressure. In addition, we supposed some advantages for this process compared with conventional ones, such as 1) utilization of inexpensive and high permeable nitrogen, 2) retention of pore pressure to avoid compaction of sediments due to increase of effective stress expected in depressurization process.

In this study, to clarify the physical phenomena in the reservoir and gas production behavior during nitrogen injection process, we have carried out the experimental study. The core holder type apparatus to enable observation of temperature change during MH dissociation was developed. Using this apparatus, some experiments for MH dissociation by nitrogen injection were conducted changing nitrogen injection rate as an experimental parameter. From the experimental observations, it was found that dissociation zone extended to the downstream zone of the sand column with time depending on dissociation rate and injection rate. Furthermore, we obtained high dissociated gas production rate in the case of high injection rate due to the multiple effect such as enhancement of dissociation and displacement of methane by nitrogen migration in pore space.