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Permeability of Artificial Methane Hydrate Sediment in Radial Flow System

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ABSTRACT

Methane hydrate (MH) is expected as a new energy source. To predict gas productvity from a MH sediment, it is necessary to make numerical model for various phenomena in order to develop a numerical simulator and carry out some parametric study for various reservor conditons and production methods. In this study, we have carried out measurements of permeability by using artificial MH sediments. To reproduce the flow condition of gas and water in a real MH field, we attempted to measure the permeability of artificial MH sediment under the horizontal radial flow condition by using disc shape samples. From experimental results, the relationship between MH saturation and permeability was clarified, and we discussed permeability change in the process of MH dissociation by depressurization.

KEY WORDS: Gas hydrate; Methane; Marine sediment, Horizontal radial flow system, Permeability; Dissociation; Depressurization.

INTRODUCTION

Methane hydrate is ice-like solid substance in which water molecule structure contains embedded methane molecules under low-temperature and high-pressure conditions (Sloan, 1998). When 1 m^3 of MH is decomposed, about 150m^3 of methane gas is produced. MH is one of the potential resources of natural gas in the near future, because the large amount of reservoir exists in marine sediments or in permafrost regions worldwide (Okuda, 1993; Sato et. al, 2001a, 2001b). Some extraction methods of MH from the reservoir in marine sediments has 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. Only methane gas can be produced from the reservoirs in marine sediments. To evaluate the productivity of methane gas from the reservoirs, it is necessary to develop the production simulator and carry out parameter study by using the simulator. Fig.1 illustrates the outline of research for MH extraction from marine sediments. Especially, it is very important to estimate the properties and the permeability of MH reservoir in such situations as dissociation and consolidation.

We have ever carried out measurement of absolute permeability with MH formation experimentally, under one-dimensional condition along the axis, using the cylindrical sample as simulated MH sediments (Sakamoto, 2007a). As a result, it was found that the influence of MH saturation on the absolute permeability was very large, so that the absolute permeability became lower with increasing MH saturation in porous media. The rate of permeability in the case of an MH saturation of 0.4 was 0.03 compared with the original values without any MH formation. On the other hand, when MH forming the structure of sediments disappears in the process of dissociation and effective stress is increased by decrease of pore pressure, we suppose that vertical consolidation of sediments occurs in a real MH field whereas gas and water flow in horizontal direction, as shown in Fig.1.

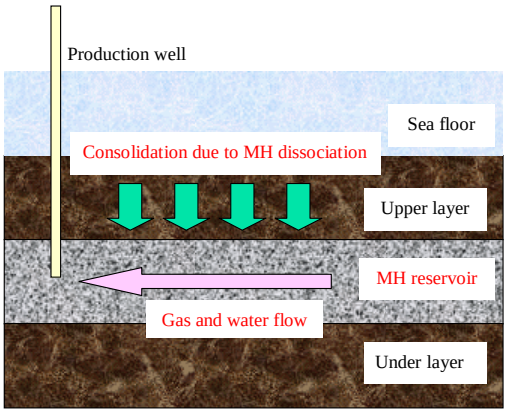

Fig.1 Schematic illustration for consolidation and flow of gas and water flow in the process of MH dissociation in a real MH field.

Therefore, it is important to develop the experimental measuring technique of permeability intended for above complicated conditions on the basis of our previous fundamental technique. In addition, considering porosity change due to consolidation, absolute permeability