Field Scale Simulation for Consolidation and Gas Production Behavior during Depressurization

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Methane hydrate (MH) is one of potential resources of natural gas in the near future, because large amount of MH exists in marine sediments or in permafrost regions worldwide. Depressurization is regarded as the most effective *in-situ* dissociation process of MH for gas recovery. In case of depressurization process, effective stress burdened on the skeleton structure of MH reservoir increases because of decrease of pore pressure, which would cause consolidation and thus permeability reduction of MH reservoir. As a result, gas productivity from MH reservoir is supposed to decrease. Therefore, it is very important to understand the behaviors in MH reservoir including consolidation, considering the gas productivity and environmental impacts due to the development.

For the purpose of introduction into the numerical simulator for MH dissociation process, an experimental study have carried out for estimation of permeability in a MH reservoir with involving consolidation of the sediments due to depressurization of pore space or increase of effective stress. In a real hydrate field, it is supposed that vertical consolidation of sediments occurs whereas gas and water flow in horizontal direction. Considering porosity change due to consolidation, consolidation-permeation tests under the horizontal radial flow condition were conducted to formulate absolute permeability as a function of porosity in addition to MH saturation of sediments. From experimental results, it was found that decrease of permeability due to consolidation was remarkable in the cases of small sand grain diameter and large initial porosity. Reduction factor was formulated for porosity through a numerical analysis, and a form of absolute permeability equation in MH reservoir was obtained.

The field scale simulation has conducted to clarify consolidation and gas production behaviors during MH dissociation process by depressurization. Reservoir model is based on the field data for Nankai Trough area in the adjacent Sea of Japan, and characterized by permeability anisotropy due to alternation of strata consisting of sand and mud layers. Some simulation runs were conducted, changing the reduction factor of absolute permeability for porosity and deformation modulus of MH saturation as calculation parameters. Based on calculated results, we considered the effect of these parameters on MH dissociation, consolidation of the reservoir and gas production behavior.

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