Thermal conductivity measurement of methane hydrate-layer sand of Nankai Trough

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Gas hydrate is a clathrate compound that is composed of guest gas molecules and host water cages. Recently, it becomes well known that there are huge amount of methane hydrate in the sediment under sea floor as same as land areas of permafrost regions. Since this gas hydrate contains large quantity of methane gas, it is considered as one of the substantial future energy resources. Thus, the investigation to recover it from the sea bottom near Japan was launched. In this investigation, thermal properties such as thermal conductivity, heat of dissociation and heat capacity of gas hydrate sediment are very important to evaluate economy of gas hydrate recovery. However, there is not enough experimental data for those thermal properties. Especially, very few data is reported for thermal conductivity of methane hydrate with soil and water. In this paper, thermal conductivity of natural sand grain, which is recovered from hydrate-layer in the sediment under sea bottom of Nankai Trough, was determined. Thermal conductivities of the natural sand grain and artificial methane hydrate (MH) mixtures were measured at the condition that imitates the real circumstances of sediment under sea bottom. Estimation of thermal conductivity of natural sand-MH-water three component mixtures was also carried out.

As a result, thermal conductivity of natural hydrate-layer sand grain (3.8-5.8 [W/mK]at263K-283K) was about 50% lower than that of Toyoura standard sand at the same condition (8.6 to 9.4 [W/mK]).Thermal conductivity of MH-sand grain mixed sample was also measured at 278K and 10MP under both CH_4 gas saturated and water saturated condition. The value was remarkably decreased with the increase of MH concentration at 0vol%-40vol%. While, it was not so much changed at higher than 40vol%.

The series-parallel conjugation model with varying the contribution factor at 40vol% of MH was tried to estimate thermal conductivity of sample mixtures. It reproduced measured values correctly. This is consistent with the idea that structure of sample should change around the concentration.

However, those data is not sufficient to evaluate thermal conductivity of real hydrate-layer. We would like to continue to measure with both artificial and real MH sediment samples to improve accuracy of estimation.

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