Experimental study on the permeability and the capillary pressure of dodecane using sintered silica particles.

Katsuya Honda[1], Kiyofumi Suzuki[2], Masamichi Ishikawa[3]

[1] Adv. Sci. Dep., Mitsubishi Res. Inst. Inc., [2] JNOC, TRC, [3] Adv. Sci. Dep., Mitsubishi Res. Inst.

The knowledge on the relations between the pore of the cap rock and the petroleum permeability and/or the capillary pressure is important to evaluate the entrapment capacity. In the current study, we try to make clear those relations by using sintered silica particles and dodecane as a cap rock and petroleum respectively, as their physical properties has been well established. The permeability and the capillary pressure measurements of dodecane on the water-wetted samples have been made under the constant flow rate conditions. The porosity of the sample has been evaluated from the cross-sectional observation. The relation between the porosity of the samples and the permeability, or the capillary pressure, has been discussed.

For the purposes of the estimation of the petroleum entrapment capacity and of understanding the entrapment mechanism, the evaluation of the seal ability of cap rock is important. The seal capacity of the rock is considered to be related to both the capillary pressure (hydrostatic feature) and the permeability (dynamic feature). Such the features may be the function of to the porosity and the throat diameter of the rock.

To clarify those relations, here we try to measure the permeability and capillary pressure as a function of porosity and/or the throat diameter. In this study we employ sintered silica particles as a rock, and dodecane as petroleum, as their physical properties have been well established. The porosity and the throat diameter of the samples were controlled by the packing density and the diameter of the particles, respectively. The permeability and capillary pressure measurements were performed under a constant flow rate condition using the high pressure fluid pump, and the pressure loss across the sample was evaluated. The porosity and the throat diameter were assessed from the cross-sectional observation of the samples using a scanning electron microscope.

The permeability of the samples can be estimated from the relation between the flow rate and the pressure loss generated. The plot of the dodecane flow rate and the pressure loss showed good linear relation in the most cases. The permeability values of the samples were in the range of milli-Darcy. The relation between the permeability and the porosity was discussed by using well known Kozeny-Carman formula.

The capillary pressure of the sample against dodecane was also estimated by the pressure loss measurement at a constant flow rate condition, whereas water and dodecane were successively applied in this case. We measured the maximum pressure loss that appeared when the water/dodecane interface attached to the sample surface. The maximum pressure loss value obtained is considered to be the sum of the capillary pressure and the pressure loss due to the dodecane permeation at the measured flow rate. As the latter was evaluated as mentioned above, we could obtain the capillary pressure by subtract the permiation pressure loss from the maximum value. The capillary pressure obtained experimentally and that estimated from the Nakayama's formula showed good coincidence.