Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

HRE29-P08 会場:コンベンションホール 時間:5 月 22 日 18:15-19:30

国内の堆積岩における数種の方法を用いたスレッショルド圧力の測定
Threshold pressure measurement by several methods on sedimentary rock in Japan

小野 正樹[1*], 亀谷裕志[2], 細田光一[1], 上堂園四男[1], 竹島淳也[2]
Masaki Ono[1*], Hiroshi, KAMEYA,[2], Kohichi, HOSODA[1], Yotsuo, KAMIDOHZONO[1], Junya, TAKESHIMA[2]

[1] 応用地質株式会社　コアラボ試験センター, [2] 応用地質株式会社　エネルギー事業部
[1]OYO Corporation Core Lab, [2]OYO Corporation Energy Division

We conducted laboratory tests to investigate threshold pressure in CO_2/water system. First technique is mercury intrusion test (MIT). Second technique is threshold pressure measurement with N_2 using step by step method. Third technique is threshold pressure measurement with supercritical CO_2 using step by step method. These techniques are commonly used but have both advantages and disadvantages. MIT is less time consuming but we cannot control the direction of injecting fluid. Test apparatus for threshold pressure measurement with N_2 is much simpler than that using supercritical CO_2. However, we have to estimate actual threshold pressure in CO_2 storage condition by converting threshold pressure in N_2/water system using interfacial tensions and contact angles. Threshold pressure measurement with supercritical CO_2 is most reliable.

Rock cores used in this study were derived from outcrop of The Yourou-valley, located in Chiba prefecture in Japan. This outcrop belongs to Kiwada formation of the Kazusa formation group which is thought to be formed in Plio-Pleistocene. Porosity of sample is 45%, natural density is 1.89g/cm^3, water content is 31%.

In MIT, we used two methods to calculate threshold pressure. By first method, we drew the tangent line with minimum grade against the curve relating saturation and capillary pressure. The tangent line is spread to the vertical line which expresses mercury saturation is zero and this intercept means the threshold pressure. By second method, threshold pressure is determined by the pressure at 10% mercury saturation1). Threshold pressure evaluated from former method is 4.08MPa and 4.87MPa is obtained by second method. Using the contact angles and interfacial tensions, we can convert threshold pressure in Hg/Air system to that in CO_2/water system. Estimated threshold pressures in CO_2/water system are 0.32MPa in first method and 0.38MPa in second method.

Threshold pressure measurement with N_2 was also conducted. Room temperature was kept approximately 21 deg c. By N_2 injection, pore water in a rock core was pushed out from a specimen but water production ceased according to the passage of time. Injection pressure was increased step-wisely when water production stopped. This procedure was repeated until continuous water flow was observed. In this test, continuous water flow was observed after injection pressure reached to 1.71MPa. We evaluated threshold pressure in N_2/water system is 1.66MPa which is average pressure of final pressure step and former pressure step (1.60MPa). Estimated threshold pressure in CO_2/water system is 0.66MPa.

Threshold pressure measurement with supercritical CO_2 was conducted under the temperature of 40 deg C. Pore water pressure of 10MP was applied to ensure that CO_2 was in supercritical state during the test. After injection pressure reached to 1.10MPa, continuous water flow occurred. Threshold pressure in CO_2/water system is evaluated 1.04MPa.

Threshold pressure estimated by MIT was lowest. Threshold pressure obtained from direct measurement with supercritical CO2 was highest value which is 1.6 times higher than that of N_2. Possible reasons for these test results are listed below;

1. Change of the structure of rock by drying procedure might affect the result of mercury intrusion test.
2. Difference of flow direction between mercury intrusion test and other techniques may have an influence on the value of threshold pressure.
3. Uncertainty of contact angles and interfacial tensions of displacing fluids is also a possible factor which leads different test result.

We gratefully acknowledge special support received from New Energy and Industrial Technology Development Organization(NEDO). Part of this study was performed under Innovative zero-emission integrated coal gasification combined cycle project.

1) Tim T. Schowalter. Mechanics of Secondary Hydrocarbon Mitigation and Entrapment. AAPG Bulletin, 1979, 63, 723-60

キーワード: スレッショルド圧力, 超臨界 CO2, 堆積岩
Keywords: Threshold Pressure, Supercritical CO2, Sedimentary Rock