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Study of measuring method for supercritical CO2 threshold pressure on several mudstone

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Geological storage of CO_2 is one of the measures to mitigate global warming. As the density of supercritical CO_2 is lower than the formation water, in order to safety storage of CO_2, it is necessary impermeable layer at the top of the aruifer. Impermeable layer such as mudstone indicates a specific threshold pressure, at the CO_2 injection pressure is greater than the threshold pressure, CO_2 penetrates into seal layer. Therefore, appropriate evaluation of the threshold pressure is important for the safety and economic efficiency of CO_2 geological storage. As the testing methods of threshold pressure, there are step by step method, residual pressure difference method, dynamic fluid method. In this paper, we propose a new method of constant ejection rate method that test time is short and to evaluate the threshold pressure from the differential pressure change. Mudstone used in the tests are collected in the outcrop of the number of domestic places, were formed into a cylindrical shape. In all tests, pore pressure is 10MPa, temperature is 40 ^{o}C, and so CO_2 becomes supercritical phase. In preparatory stage of each test, permeability measurements were performed by steady state method

The test I were carried out by step by step method as the confining pressure is 20MPa. Water ejection has started at the differential pressure reaches to 1.24MPa and 70 hours elapsed from the start of CO_2 injection through 0.1MPa pressure increments every six hours. Threshold pressure is 1.24MPa to be evaluated.

The test II were carried out at constant ejection rate method as the confining pressure is 12MPa. The flow rate of ejection was controlled 0.004ml/min constant. Pore pressure of ejection side is decreased rapidly after 4 hours, showed a differential pressure 0.71MPa after 10 hours. The differential pressure change of 0.59MPa from 0.12MPa to 0.71MPa is considered equivalent for the threshold pressure.

The test III were carried out at constant ejection rate method as the confining pressure is 20MPa. Strain changes were observed at the injection side and ejection side. The threshold pressure was evaluated as 0.85MPa. At the same time of the reduction of ejection pressure, compressive strain were observed at both side of injection and ejection. This suggests that the threshold pressure is expressed with the CO_2 arrival to the end face and pore pressure was reduced uniformly. Expansive strain was observed at injection side 3 hours after the reduction of ejection pressure and expansive strain was observed at enjection side 11 hours after the reduction of ejection pressure. This suggests that the increase of pore pressure at the point of CO_2 reached causes expensive strain.

The permeability of test I, test II and test III, were 3.1, 9.3 and 6.5 x10^{-6} darcy respectively. The relationship between threshold pressure and reciprocal permeability showed a clear positive correlation on both logarithm. Threshold pressure of supercritical CO_2 was higher than the threshold pressure of N_2. Whereas the threshold pressure has been evaluated 70 hours after in the step by step method, could be evaluated 10 hours after in constant ejection rate method. The possibility of shortening the test time has been confirmed. Observation of the strain is useful in the interpretation the behavior of CO_2.

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