Impact of the injection speed on CO_2 saturation and pore pressure

*Keigo Kitamura[1], Hiroyuki Honda[2], Shinnosuke Takaki[2], Mitsunori Imasato[2], Yasuhiro Mitani[3]

1. International Institute for Carbon-Neutral Energy Research, Kyushu University, 2. Graduate School of Faculty of Engineerring, Kyushu University, 3. Faculty of Engineerring, Kyushu University

It is an essential issue to understand the behavior of injecting CO2 in reservoirs. Injected CO2 forms two-phase flow with brine and arises CO2 saturation (SCO2) and pore fluid pressure(Pp). The estimation of SCO2 in the reservoir is one of important task in CCS projects. Fluid pressure (Pp) is also important to estimate the integrity of CO2 reservoir and overlying cap rocks. Generally, elastic waves are used to monitor the changes of SCO2. Previous experimental and theoretical studies indicated that SCO2 and Pp are controlled by the fluid velocity of invaded phase. In this study, we conducted the CO2 injection test for Berea sandstone (Φ=18.1%) under deep CO2 reservoir conditions. We try to estimate the changes of SCO2 and Pp with changing CO2 injection rate (FR) from 10 to 5000 ml/min for Berea sandstone. P-wave velocities (Vp) are also measured during CO2 injection test and used to investigate the relationships between SCO2 and Vp and Pp. We set 3 Vp-measurement channels (ch.1, ch2 and ch.3) to monitor the CO2 behavior. The result shows step-wise SCO2 changes with increasing FR from 9 to 25% in low-FR condition (10-500 ml/min). Vp also shows step wise change from ch1 to ch.3. Ch.1 indicates that Vp-reduction stops around 4% at 10ml/min condition. However, ch.3 changes slightly from 4% at 10 ml/min to 5% at 100 ml/min. On the other hand, differential Pp (DP) dose not shows obvious changes from 10 to 30kPa. Over 1000 ml/min, SCO2 increases from 35 to 47 %. Vp show slight reductions and Vp-reductions reach constant values as 8%, 6% and 8%, respectively at 5000 ml/min. Then, DP shows rapid increasing from 50 to 500 kPa. It suggests a drastic change of CO2 behavior with injection rate. CO2 flows gently and enlarges SCO2 up to 25 % under low FR conditions without arisen DP (<500 ml/min). Over 1000 ml/min, CO2-flow causes rapid increment of SCO2 and DP. These results clearly indicate that SCO2 and DP are strongly controlled by CO2 injection rate.

Keywords: CO2 saturation, differential pressure, injection speed, two-phase flow

