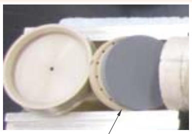
Development of Carbon Dioxide Microbubble Sequestration into Saline Aquifer and CO_2-EOR Reservoirs

Introduction

To study the effect of microbubble injection for CO_2 dissolution, we carried out laboratory experiments of CO_2 flooding in porous sandstone (Berea sandstone). Using X-ray CT image analysis, porosity estimation and CO_2 saturation monitoring were conducted. A long core specimen was used to determine how much the microbubble effect reached in our experiment system. On the basis of experimental results, we try to evaluate the superiority of microbubble injection for CO_2 dissolution by comparing the difference between microbubble and normal-bubble injections. We expect that the microbubble CO_2 injection technique will contribute to geological CO_2 sequestration.

Rock specimen

Berea sandstone (diameter: 34.85mm, length: 288.00mm) was used in this study. It has bedding planes parallel to the core axis. We set the bedding planes horizontally. Microbubble filter (diameter: 34.80mm, length: 4.00mm) was located in between distributer and core specimen in upstream side.



microbubble filter

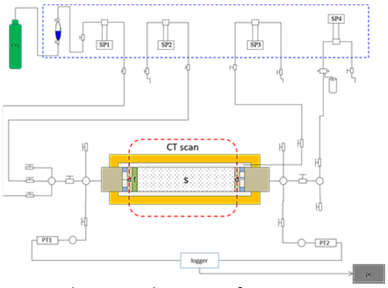
288mm long core specimen

Physical properties of specimen & MB filter

	diameter (mm)	length (mm)	bulk volume (cm^3)	porosity (%)	sample pore volume (cm^3)	permeability (mD)
Berea sandstone	34.85	288.00	274.72	19.70	54.12	131
microbubble filter	34.80	4.00	3.80	31.28	1.19	-

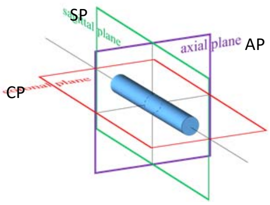
Test system

The experiments were carried out under the pressure and temperature conditions that simulate underground environments; pore pressure: 10MPa, temperature: 40 degrees Celsius. The confining pressure of 15MPa was selected in this study. The syringe pumps on the upstream side was controlled to maintain 0.05ml/min (constant flow control). And the syringe pump on the downstream side was controlled to maintain 10 MPa.



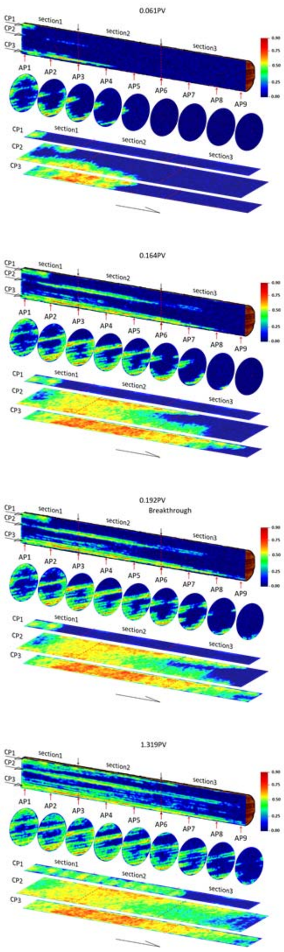
Schematic diagram of test system

SP: syringe pump (SP1: CO_2, SP2: water, SP3: confining oil, SP4: back pressure), S: rock sample, PT: pressure transducer, d: distributor, f: microbubble filter

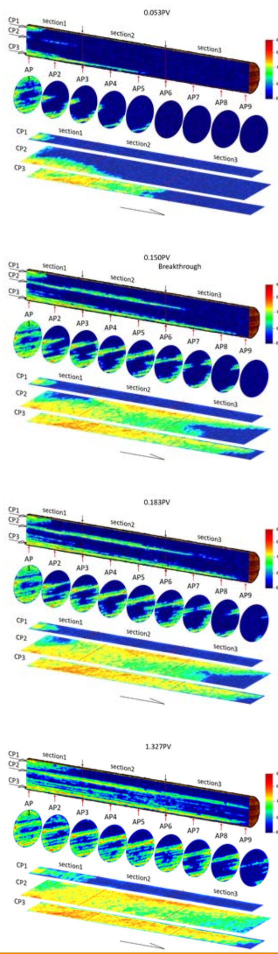


Major cross Sections in CT

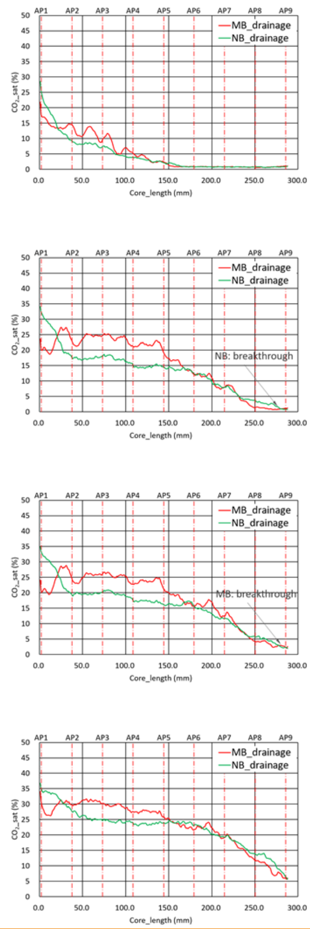
microbubble



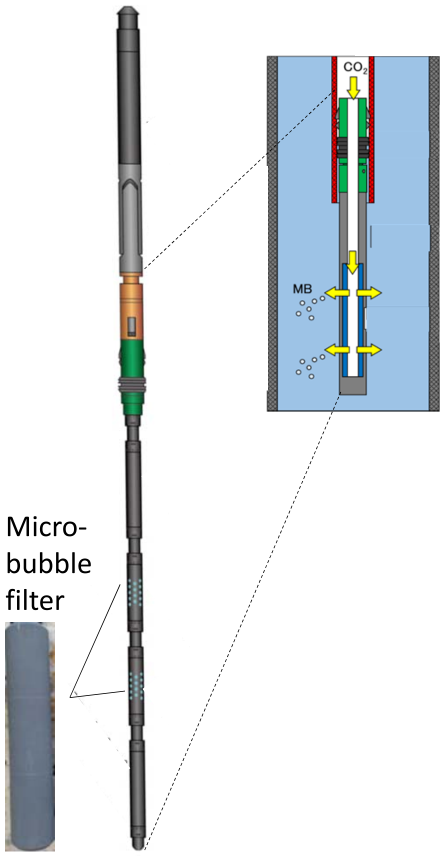
normal-bubble



CO_2 saturations



Field application



Conclusions

- CO_2-flooding laboratory experiments of porous sandstone (Berea sandstone; long core specimen; 288mm) and X-ray CT visualization were carried out to study the effect of microbubble injection for CO_2 dissolution.
- We could estimate the porosity of specimen and visualize the process of water injection and CO_2-flooding process by the X-ray CT image analysis. CO_2 saturations during the experiments were also obtained.
- The CO_2 saturation distributions along the specimen were different in between the cases of microbubble and normal-bubble CO_2 injections. At each breakthrough point, there was a difference of about 5% points of CO_2 saturation. It reveals that the microbubble CO_2 injection has more advantage to the CO_2 dissolution for geological CO_2 sequestration.

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