New Unsteady State Method for Obtaining CO₂ Relative Permeability

Scientific Achievement
Developed a method for obtaining accurate and quick measurements of high pressure CO₂ relative permeability.

Significance and Impact
Relative permeability is the crucial parameter for predicting fate, transport, and trapping of CO₂ on reservoir scales.

Research Details
- By using in-situ saturation measurements, long cores (2’ as opposed to 2”), and pressure taps, we can avoid end effects which are great with low viscosity fluids such as CO₂.
- With a unique mathematical inversion, we determine in-situ fluxes during a CO₂ displacement allowing for an increase by a factor of 10 of the amount of rel perm data.


Work was performed at the University of Texas at Austin
Relative permeability is the key parameter for predicting fate of CO$_2$ at reservoir scale

Previous measurements of CO$_2$ relative permeability show low CO$_2$ permeabilities when compared to other fluids (see figure)

This has been interpreted to CO$_2$ having special wetting properties, but more likely is just an experimental artifact due to the low viscosity of CO$_2$ compared to most other fluids tested (usually a hydrocarbon)

Goal: Develop a robust method that

a) obtains accurate relative permeability data without artifacts

b) obtains data quickly (less than 1 week)

c) greatly increases the number of data points

Many previous measurements of relative permeability a factor of 5 lower than expected. If true, this has great implications on fate of CO$_2$.

To avoid the experimental artifacts caused by CO₂’s low viscosity, we use
- CT scanning to obtain in-situ saturation measurements
- Pressure taps to obtain in-situ pressure measurements

We developed a new mathematical inversion to obtain local CO₂ velocity during a displacement
- This allows direct calculation of relative permeability

Flow schematic with 4 pressure taps for in-situ pressure measurements
Results: CO2 behaves normally

- New method obtains 100s of data points in less than 1 week
- Data is clear of end effects
- CO2 relative permeability is very similar to hydrocarbon permeability, and a factor of 5 higher than previously measured

In-situ saturations versus time during displacement. Many more data points using new method reducing the error in the measured relative permeability.