Development of a velocity and concentration measurement method for CO$_2$ dissolution in brine within a Hele-Shaw cell

MENGYE ZHAO, KENNETH KIGER, University of Maryland, ANKUR KISLAYA, JERRY WESTERWEEL, Delft University of Technology — We perform quantitative velocity and concentration measurement within a Hele-Shaw cell Rayleigh-Benard convection as CO$_2$ dissolves into brine. The velocity is measured using PIV under large depth-of-field and gap-wise Poiseuille flow conditions, making reliable quantitative velocity measurement difficult due to the large velocity gradient across the gap. Previously, particle sorting has been purposed and validated as a means to resolve this problem. The method flushes particles along the cell until all have migrated to their gap-wise equilibrium plane, thus providing an unambiguous velocity magnitude. However, in order to accomplish the sorting, a large portion of the test cell will not be usable for measurement. We purpose a new method to overcome this limitation. We first conduct PIV without sorting particles to obtain only the velocity direction. This provides the value of the in-plane velocity ratio ($u/v$) at every $x, y$ coordinate pair. We then obtain the CO$_2$ concentration map using fluorescent emission of a pH sensitive dye. Having mapped the concentration, we combine the $u/v$ information and solve the CO$_2$ advection-diffusion equation to get the value of $u$ and $v$. We demonstrate this method by comparing its result with that from the particle sorting method.

Kenneth Kiger
University of Maryland

Date submitted: 01 Aug 2019

Electronic form version 1.4