Contribution ID: **131** Type: **Oral Presentation**

Pore-scale Investigation of the Capillary Pressure Effect on the Upward Migration of Hydrogen through Water-filled Porous Media

Friday, 4 June 2021 14:30 (15 minutes)

An efficient energy-management strategy is critical for the fast transition of the global energy sector towards operation with 100% renewable or low-carbon energy, of which energy-storage is a key part. Among energy storage technologies, the geological storage of hydrogen, utilising excess or curtailed renewable energy and electrolysis has emerged as a Terawatt-scale, clean and sustainable energy storage technology. As such, understanding the complex flow behaviour of hydrogen in these storage reservoirs is critical. In this study, we explored how hydrogen with a lower density than water migrates through water-filled porous media, aiming at characterising the interplay of the gravity and capillary forces. Two dimensional multicomponent-multiphase (MCMP) lattice Boltzmann (LB) simulations were conducted using the Shan-Chen pseudo-potential model with a D2Q9 configuration. The model was firstly validated by conducting a numerical simulation for Poiseuille flow and comparing the simulation results against the analytical solution and performing a MCMP simulation for capillary rise phenomenon in a capillary tube. The validated model was then used to simulate the upward (y-direction) migration of a hydrogen plume with an initial saturation (Sh,i) of 10% in a porous column, partially filled with water (Sw,i = 90%). The porous column is homogeneous, consisting of equally sized grains (r), placed with a simple cubic packing configuration. Periodic boundary conditions were considered at the right and left borders of the column and a half-way bounce-back boundary condition was assumed for all solid boundary conditions as well as the boundaries at the top and bottom. The effect of the capillary pressure on the upward migration of hydrogen was captured by: (i) running the LB simulation at different "r"values while keeping the porosity at a typical cubic packing constant value (~40%), (ii) obtaining the ultimate saturation (Sh,u) of accumulated hydrogen at the 10% upper region of the porous medium at the equilibrium conditions, and (iii) comparing Sh,u with Sh,i. The simulation results confirm that the structure of mesoporous media control, the dynamics of gravitationally unstable flow and the capillarity have a major contribution to the flow behaviour of hydrogen. Ultimately, the results have implications for accurate projection of the hydrogen plume evolution and as such the design of various storage options and well production strategies.

Time Block Preference

Time Block B (14:00-17:00 CET)

References

Acceptance of Terms and Conditions

Click here to agree

Student Poster Award

Primary author: VASHEGHANI FARAHANI, Mehrdad (Institute of GeoEnergy Engineering, Heriot-Watt University, UK)

Co-authors: Dr HASSANPOURYOUZBAND, Aliakbar (School of Geosciences, University of Edinburgh, UK); Dr EDLMANN, Katriona (School of Geosciences, University of Edinburgh, UK)

Presenter: VASHEGHANI FARAHANI, Mehrdad (Institute of GeoEnergy Engineering, Heriot-Watt University, UK)

Session Classification: MS1

Track Classification: (MS1) Porous Media for a Green World: Energy & Climate