Imperial College London

Natural Environment Research Council

2023_33_ESE_Jackson: Efficient numerical modelling of subsurface hydrogen storage for low carbon energy

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Large-scale, subsurface hydrogen storage has been proposed as a means to deliver low carbon energy. Hydrogen could directly replace natural gas in distribution networks for industrial and domestic use. Hydrogen could also be used for electrical energy storage: excess renewable supply is used to produce hydrogen which is stored and later used as a low-carbon fuel for electricity generation. However, predicting the subsurface response to hydrogen storage, the movement of hydrogen during injection and production in subsurface reservoirs, and the optimal operation of hydrogen storage projects, requires numerical models that can capture the complex dynamics of hydrogen flow. Research to date has shown that hydrogen storage is associated with multiphase fluid flow in geologically complex storage reservoirs, and a range of complex chemical and biological reactions.

This project will apply advanced numerical methods implemented in the open-source Imperial College Finite Element Reservoir Simulator (IC-FERST) to simulate subsurface hydrogen storage and assess (i) storage volumes and storage efficiency for a range of potential storage reservoirs; (ii) hydrogen plume migration and the impact of geologic heterogeneity; (iii) impact of chemical reactions and microbial activity on sustainable operation, and (iv) controls and risks of hydrogen leakage. IC-FERST incorporates state-of-the-art technology for reservoir simulation, including unstructured dynamic mesh optimisation (DMO), high order discretisation, and a surface-based representation of complex reservoir architecture.

Applicants should hold a degree in an appropriate subject (e.g. earth science, physics, mathematics or engineering) and a strong interest in computational modelling. The project is hosted by the NOvel Reservoir Modelling and Simulation (NORMS) group in the Department of Earth Science and Engineering (ESE) at Imperial College, a vibrant, multi-disciplinary group of earth scientists, computational physicists and engineers. The project will involve extensive interactions with other research groups within and beyond ESE. Industry partner OpenGoSim (www.opengosim.com) offer an enhanced stipend and a 3 month internship that will provide practical industry experience. Skills developed during this project will include numerical modelling of multiphase porous media flow, high performance computing, CAD modelling, geological modelling, dynamic mesh optimisation and unstructured meshing. The successful candidate will be encouraged and supported to develop their career and profile, including presenting at national and international conferences and publishing articles in leading journals.